THE POSSIBLE CONTRIBUTION OF *MORINGA OLEIFERA* LAM. LEAVES TO DIETARY QUALITY IN TWO BAPEDI COMMUNITIES IN MOKOPANE, LIMPOPO PROVINCE

by

ADELAIDE OWUSU AGYEPONG

Submitted in part fulfilment of the requirements for the degree of

MASTER OF HUMAN ECOLOGY

in the subject

HUMAN ECOLOGY

at the

UNIVERSITY OF SOUTH AFRICA

Supervisor: Mrs FM Ferreira
Co-supervisor: Dr MA Mearns

February 2009

DECLARATION

I ADELAIDE OWUSU AGYEPONG declare that 'The possible contribution of *Moringa oleifera* Lam. leaves to dietary quality in two Bapedi communities in Mokopane, Limpopo Province' is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Signature:……..

A O AGYEPONG

Date: ……

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the Almighty God who kept me safe and sound throughout my academic journey and also to the following people:

- Dr. Mary Masafu, who first stimulated my interest in *Moringa* as a miracle tree. I wouldn't have started this dissertation if it weren't for her.

- My husband, Mr. D O Agyepong who supported and encouraged me throughout the studies. At a time when I wanted to give up, he wouldn't hear of it and was always optimistic. He was so involved in my studies to the point of knowing so much about *Moringa* and recommending it to other people.

- My girls; Vanessa, Abena and Afia whom I thank so much for their help. Whenever I had to work late on my dissertation, they accommodated me and did the chores which enabled me to concentrate on my work.

- Mrs Fransa Ferreira for her supervision, support and guidance throughout this study. I thank her for being my advisor and for mentoring me at the same time. I couldn't have come this far without her.

- Dr. Martie Mearns for her assistance, contribution and patience. She first gave me the opportunity to work as her research assistant; a threshold into academia. I really appreciate the commitment she exhibited in this work.

- The College of Agriculture and Environmental Sciences at UNISA for financial support by the Executive Dean's Office in the form of a research assistant's position which was made available to me.

- Mr. J Rathelele, Ms Koma and Mrs Jacobs for accompanying me on my field trips.

- Ms Madisha, Sister Glory and all at Mokopane who assisted me while I was conducting this research.

ABSTRACT

A high rate of micronutrient deficiencies persists in Africa with the most vulnerable groups being women and children. The *Moringa oleifera* tree has been identified to help alleviate malnutrition at household level because of its rich content of vitamin A in its plant form - beta-carotene, iron and vitamin C.

The objectives of this study was to identify households that consumed *Moringa*, to identify households that required diet diversification through the use of a Household Dietary Diversity Score (HDDS) and to determine the acceptability of various dishes prepared from *Moringa* leaves as a possible contribution to the alleviation of malnutrition in resource poor communities.

The dietary diversity score of the traditional Bapedi community is 4.7 and the results of the acceptability test of dishes prepared with *Moringa* indicated that *Moringa* could be recommended as an additional food ingredient to add micronutrient to the diet of Bapedi communities.

Key words: *Moringa,* Traditional leafy vegetables, Dietary diversity, Food acceptability

TABLE OF CONTENTS

CONTENTS **PAGE**

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

OVERVIEW AND RATIONALE

1.1 Introduction

"Life on this planet has been likened to a pyramid: a pyramid with an unbelievably wide base and a small apex….. Humans are somewhere near the top but not at the top because they are omnivores. They are one of those lucky animals that can subsist on a wide range of food: vegetable and animal" (Seymour, 2003). Although Seymour rightly says humans can survive on a wide range of food, it is also known that it's not every food when eaten that provides the body with the nutrients that it needs and not having the right quantity of nutrients one needs can lead to malnutrition.

1.2 Rationale

Recently the concept of biodiversity in the form of food based supplementation as a mechanism to possibly provide diversity to the diets of people is prominent in nutrition research on food sources available in Africa and Asia (Johns, 2003). It is a concern that the original or cultural knowledge of people concerning foods and the nutritional value thereof are being lost to diet transition with migration and urbanization (Kuhnlein, 2002). The food compositions of a diverse range of foods have been analysed and more still have to be analysed as initiated in FAO projects lately (FAO, 2008). Johns (2003) and Kuhnlein (2003) suggests that with the knowledge of nutritional analysis, a range of foods could be introduced to supplement the diet of a household to improve food and nutrition security. Both authors view more research on traditional foods, such as traditional leafy vegetables, and its contribution in micronutrient contents as a positive step towards health promotion or intervention strategies (see Paragraph 1.3.3 and 2.6).

1.2.1 *Moringa oleifera* Lam. as a nutritious food source

Moringa oleifera Lam, belongs to the Moringaceae family, which is a single genus family with 14 known species. Of the 14 known species, *Moringa oleifera* Lam is the most widely known and utilised species. *Moringa oleifera* Lam will be referred to as *Moringa* throughout the remainder of this study. *Moringa* is native to the sub–Himalayan regions of India and is now naturalised in many countries in Africa, Saudi Arabia, South-East Asia, the Caribbean and South America (Murro, Muhikambele, and Sarwatt, 2003). It is a fast growing tree, which can reach 12 m in height at maturity. The plant is also

known as the ‘drumstick’ tree, derived from the shape of the pods resembling a drumstick (Rachmandran, Peter, and Gopalakrishnan, 1980).

Moringa has received attention in many countries in the tropics and sub-tropics and its leaves, pods and seeds form part of the traditional cuisine in these countries. Although *Moringa* is used in West, Central and East Africa and although it grows in some parts of South Africa, the plant itself, as well as its uses, are mostly unknown to South Africans in general (National Research Council, 2006). Literature study and a few informal discussions held in Tshwane and Mokopane in the Gauteng and Limpopo provinces of South Africa respectively indicated that although some people use *Moringa* in their diets (mostly Indians) its usage is not documented in South Africa. However, the listing of *Moringa* as an herb in South Africa in a recent publication (Roberts, 2007) may be an indication that awareness of the plant in South Africa is on the increase. There is therefore an opportunity to introduce *Moringa* as a food source, which could lead to an increase in diversity of the dietary intake, especially among rural populations of South Africa.

Fahey (2005), in a scientific publication, refer to popular publications promoting *Moringa* as a nutrient dense food source and give the following information: The importance of *Moringa* lies in the high nutritional value of its leaves, pods and seeds. “100 g of *Moringa* leaves contain four times more vitamin A than the same quantity of carrots; four times the calcium in a cup of milk; more iron than 100 g of spinach; seven times the vitamin C in 100 g of oranges and three times the potassium in 100 g of bananas. The protein quality of *Moringa* leaves also rivals that of milk and eggs” (Fahey, 2005). The scientific determined nutritional values reported in the literature of *Moringa* leaves and pods are documented and discussed in detail in Paragraph 2.4 (Fuglie, 2001).Therefore, *Moringa* is a relatively good source of vitamins, minerals and essential amino acids and could be considered as a good alternative to be used to help alleviate micronutrient malnutrition at household as well as national level.

1.2.2 Malnutrition, food security and dietary diversity

Malnutrition is caused by the deficiency of either macronutrients or micronutrients or both. Micronutrient malnutrition is usually referred to as hidden hunger. Hidden hunger is also associated with food insecurity and dietary diversity, especially if foods of a low dietary quality are consumed (Ruel, 2003).

1.2.2.1 Malnutrition

Malnutrition is a worldwide health problem and the most important risk factor for illness and death contributing to more than half of all deaths in children globally (WHO, 2000). Malnutrition is divided into two categories namely overnutrition and undernutrition. Within undernutrition a differentiation can be made in terms of protein-energy malnutrition (PEM) and micronutrient malnutrition. Coovadia and Wittenberg (2003) reported that the highest global nutritional disorder is PEM with Marasmus and Kwashiorkor being the most severe forms. In addition to PEM, children may be affected by micronutrient deficiencies, which also have a detrimental effect on growth and development (WHO, 2000). Unfortunately, unacceptably high rates of micronutrient malnutrition persist at the present moment in Africa in spite of commitments made at an international conference on nutrition held in 1992 and also at the World Food Summit held in 1996 to drastically reduce micronutrient malnutrition (Aphane, Chanda, and Olouch, 2003).

South Africa is a developing country in which micronutrient deficiency continues to be a major health problem, especially among children (Aphane *et al.*, 2003; Wenhold and Faber, 2006). egard, In this regard in South Africa, the micronutrients of major concern include vitamin A deficiency (VAD), iron deficiency and iodine deficiency, with zinc being recently added (Labadarios, Van Middelkoop, Coustsoudis, Eggers, Hussey, Ijsselmuiden, and Kotze, 1995). In this regard, in South Africa, the micronutrients of major concern include vitamin A deficiency (VAD), iron deficiency and iodine deficiency, with zinc being recently added (Labadarios, Van Middelkoop, Coustsoudis, Eggers, Hussey, Ijsselmuiden, and Kotze, 1995). Of relevance to this research is VAD as one of the research areas in traditional food systems research finding unique foods for food and nutrition security (Kuhnlein, 2003). A traditional food system is referred to by Kuhnlein (2003) as all food a particular group available food from local resources and food culturally accepted, also including socio-cultural meanings, acquisition and processing techniques, use, composition, and nutritional consequences for people using the food.

Although only VAD is reported in Figure 1.1 below, it is viewed as one of the indicating factors to focus in this study on the nutritional possible of *Moringa* and traditional leafy vegetables as important food sources or food-based supplements for a number of micronutrients important for nutritional health (see Paragraph 2.4 and 2.8). It has been shown in a recent survey that 33% of South African children under the age of six suffer from VAD (Coovadia, 2003). According to Labadarios *et al* (1995), a study undertaken by the South African Vitamin A Consultative Group (SAVACG) in 1994 on VAD in children

between six months and six years of age in South Africa resulted in the percentages shown in Figure 1.1

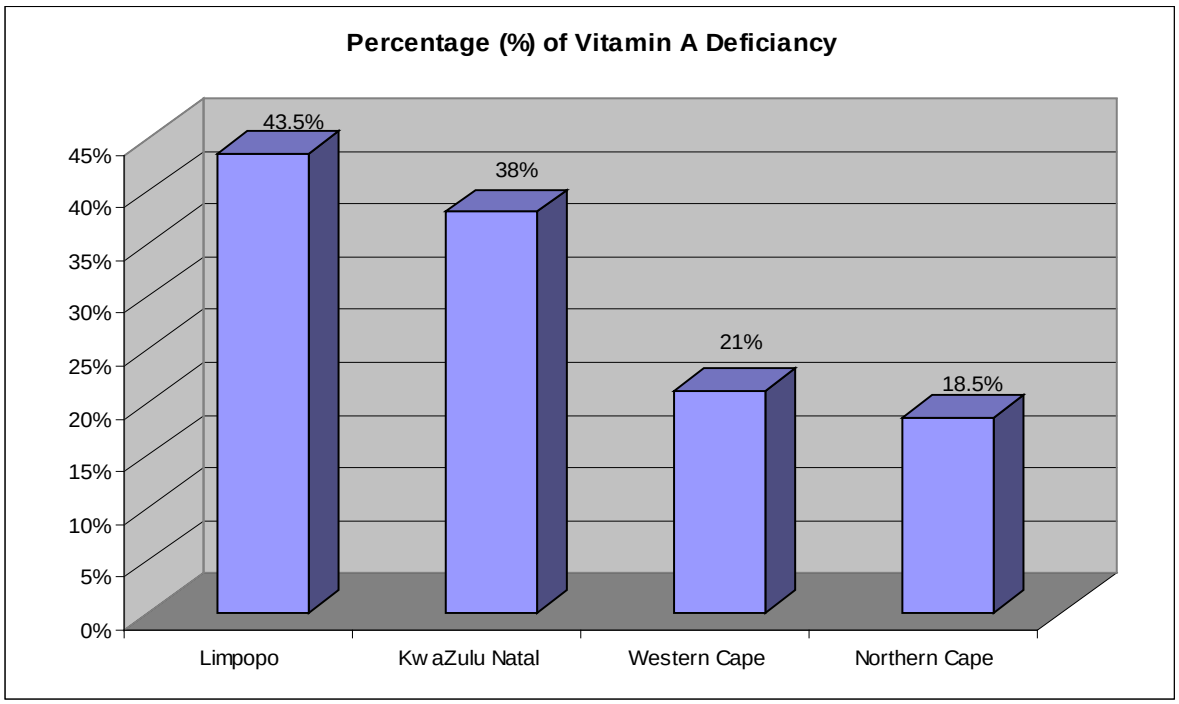

Figure1.1: Occurrence of VAD in children aged between 6 months and 6 years (Adapted from Labadarios *et al*., 1995)

As shown clearly in Figure 1.1, the highest occurrence of VAD was amongst children in the Limpopo Province and this could be associated with food insecurity. Of specific relevance to this research is the high occurrence of VAD amongst children in Limpopo Province (Labadarios *et al.,* 1995). Two studies the National Food Consumption Survey (NFCS) (Labadarios, 2000) and Everatt and Smith (2008) on sustainable livelihoods reports on access to food and hunger (See Chapter 2 and 4). For further motivation identifying diet quality as an important concept in the study there is a need to include food security in the discussion.

1.2.2.2 Food security

United States Agency for International Development (USAID) defines food security as, “when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life”. There are three main components of food security. These are: food availability, food accessibility and food utilisation. The USAID (2006) policy statement defines *food availability* as “sufficient quantities of domestic production, commercial imports or donors that are

consistently available to individuals within a household". It defines *food accessibility* as "the ability to acquire sufficient quality and quantity of food to meet all household members' nutritional requirements for productive lives". It defines *food utilisation* as occurring when food is properly used, processed and stored and "adequate knowledge of nutrition and child care exists and is applied, and adequate health and sanitation services exist". These three components of food security determine a household's dietary quality and dietary diversity through the consumption of a number of different food groups over a given period. Lately, a fourth component has been added, namely food stability, which affects all three components (Klennert, 2005).

The National Food consumption Survey (NFCS) of 1999 for children between the ages 1>9 years in South Africa provides evidence for this research (Labadarios, 2000). This comprehensive study highlighted in a range of aspects influencing nutritional health of households and specific those with children under ten years of age. The study reports on the food consumption, intake of macronutrients and micronutrients, access to food, hunger, food insecurity, food procurement (acquisition) and inventories (See Chapter 2 and 4).

1.2.2.3 Dietary quality

Dietary quality refers to the adequacy of nutrients in the diet. Dietary quality has two components, namely dietary diversity and dietary or food variety (Ruel, 2003; SCN, 2007). *Dietary diversity* is described as the number of foods or food groups consumed over a given period (Drewnowski, Henderson, Driscoll, and Rolls, 1997). Ruel (2003) and Onyango (2003) also indicate that dietary diversity is directly related to dietary quality.

For this research dietary diversity will be associated with mainly micronutrient deficiency with the focus on mainly vitamin A. A household can reflect quality diets if that household is food secure; through dietary quality, the nutritional needs of the household will be supplied (Ruel, 2003). It is important that dietary intake is improved since a diet inadequate in nutrients due to food insecurity can be the immediate cause of malnutrition (Wenhold and Faber, 2006). This is especially true of children, due to their needs during their lifecycle and the different stages of their development.

Moringa leaves can make a contribution to the dietary diversity and dietary quality of households in need of improving their nutritional intake. However it is also important to confirm its acceptability since it is an unknown food to Southern African cultures. The acceptability of *Moringa* leaves has therefore been tested in households belonging to the Pedi culture, being the cultural grouping that outnumbers all other cultures in the Limpopo Province (see Paragraph 2.8.2 and 2.8.3).

1.3 Traditional leafy vegetables, acceptability and intervention strategies

Traditional leafy vegetables refer to both indigenous and indigenised leafy vegetables. *Indigenous leafy vegetables* refer to the plant species which are genuinely native to a particular region or which were introduced to that region long enough to have evolved through natural processes or farmer selection. *Indigenised leafy vegetables* refers to leafy vegetable species in a particular region which were externally derived but have since been accepted and incorporated into the local or traditional food culture (Jansen van Rensburg, van Averbeke, Slabbert, Faber, van Jaarsveld, van Heerden, Wenhold, and Oelofse, 2007). For the remainder of the study reference will be made either to indigenous vegetables or traditional vegetables interchangeably to refer to both indigenous and indigenised vegetables as defined here.

1.3.1 Traditional leafy vegetables in South Africa as a food source

A Pedi proverb “Meat is a visitor, but morogo a daily food” (Hart and Vorster, 2006) indicates the reality of consuming wild leafy vegetables in most Bapedi households in rural communities. Morogo is the collective name given to traditional vegetables by the Bapedi. These households rely on wild traditional plants or cultivated plants as a food source; many of which are indigenous to South Africa, though some originate from other parts of the world (Hart and Vorster, 2006). Studies in different areas of South Africa indicate differences in cultural preferences for traditional leafy vegetables and the practice of mixing leafy vegetables into dishes is common (Shava, 2000 and Nesamvuni, 2000). These studies also indicate that traditional leafy vegetables are high in micronutrients such as vitamin C, folic acid, iron and beta-carotene. Consumption of traditional leafy vegetables is therefore found to be the most sustainable way of adding diversity to the diet; thereby controlling micronutrient deficiencies (see Paragraph 2.4 and 2.8).

1.3.2 Food acceptability

Dietary diversity also has a relationship with food acceptability in terms of food preference with geographic, socio-economic and cultural dimensions (Den Hartog, van Staveren, and Brouwer, 2006). *Food acceptability* can be summarised as the extend of liking or disliking of a particular product and *food preference* as the selection of a number of products on the basis of liking or disliking by a group of people. The term “hedonic testing” applies to rating scale used for both acceptance and preference testing (Drewnowski, 1999; Den Hartog *et al.,* 2006). This is an important factor for intervention,

awareness creation and innovation in the matter of adopting new varieties of food (see Paragraph 2.6).

1.3.3 Intervention strategies

In making people aware of nutritious foods and promotion thereof different intervention strategies can be used. Although intervention is not an objective of this research, the action research approach which uses participation as a driving force and initiates learning in communities, opens up avenues for future intervention which cannot be ignored (Reason and Bradbury, 2006). Therefore, the unit of analysis is social groups involved in community work or training in the second cycle (see Paragraph 3.3.1). Kuhnlein (2003) describes this kind of action research using quantitative and qualitative methods as background research to any intervention programme.

The purpose of this research study is to highlight the use of *Moringa* and traditional green leafy vegetables towards an end goal of micronutrient intervention, although the research may only inform and include the planning of intervention strategies *per se*. The reviews of *Moringa* include some intervention strategies used in Africa and are discussed in Paragraph 2.6. Food acceptability and adoption of *Moringa* as a food source play an important role in these intervention strategies through the use of awareness, innovation and diffusion strategies (Babu, 2000). In this regard therefore, the study and the possible introduction of *Moringa* into the diets of people in Limpopo Province could prove useful, so will become the end goal towards which the research will be conducted.

The rationale for the choice of conducting this research in Limpopo Province can be summarised as follows: the plant *Moringa,* with its high nutritional value, does grow in the environment of Mokopane and may relieve the effects of food insecurity by providing dietary quality. Furthermore the possibility exists of *Moringa* being culturally acceptable as an additional nutritious dark green traditional leafy vegetable to the Bapedi communities in the region.

1.4 Research aim and objectives

The research aims to investigate the usage of *Moringa* leaves in the diets of existing users and to investigate the possibility of introducing the plant to households in need of diversifying their dietary intake. The research objectives are as follows:

(1) To establish the usage patterns of *Moringa* in diets, reasons for usage and associated indigenous knowledge.

(2) To assess variations in peri-urban and traditional Bapedi households in terms of diet diversification.
(3) To establish the usage patterns of green leafy vegetables traditionally eaten by Bapedi households.
(4) To determine the acceptability of dishes prepared by substituting traditional green leafy vegetables with *Moringa* leaves.

A brief description of the research design that was followed in order to attain the above aims and objectives is discussed below. The research methodology is discussed in Chapter 3.

1.5 Research design

The research design represents the research paradigm, research methodologies and the action research cyclical process to which this research subscribes.

1.5.1 Paradigm

Action research can be associated with a new participatory paradigm developing, rather an orientation to inquiry drawing on the range of perspectives and approaches that are available to the researcher (Reason & Bradbury, 2006). Action research comprises a family of research methodologies bringing together a variety of research and intervention methods of a quantitative and qualitative nature in a research design. Action research aims to pursue action in cyclical events to encourage change and research outcomes at the same time to increase knowledge suited to situations where one wish to achieve change (Reason & Bradbury, 2006).

1.5.2 Action research and mixed methods

Cresswell (1994) suggest that in a mixed methodological design aspects of the qualitative and quantitative research methodologies might be mixed in the introduction, literature review, use of theory, in the statement of purpose or in the research questions. Although it commonly adds complexity to a design the advantages of both qualitative and quantitative methodologies are used. It is within this perspective that the research design for this study lends from both qualitative and quantitative methodologies to address the gathering of data, making use of semi-structured interviews, focus group discussions and untrained community taste preference panels.

In terms of a typology of research design types the research is classed as empirical and primary data is gathered using an action research approach. Action research makes use of three sequential stages in a cyclical process (Obrien, 2001). The research was carried out in three phases after the pilot study as elaborated in Paragraph 3.3 and 3.4. Action and reflection on each phase led to the next phase, using the same methods of data gathering but purposive criteria for each of the three samples. The first sample from the Indian community as the reference group for *Moringa* information was planned according to the identification of the specific research problem. The selection of following two samples was informed by the reflection of the previous cyclic phase and the purposive criteria set and planning done for the next cyclic phase. This short description should briefly inform the following chapters.

1.6 Outline of the study

Chapter two gives a literature review of the uses of *Moringa* in countries outside Africa and within Africa and is followed by other uses of *Moringa* apart from it being used as a food source. Chapter three provides the methodology of how the study was conducted, as well as experiences during the data gathering field research. Chapter four focuses on the research findings in relation to the stated aim and objectives of the research. Finally, Chapter five provides a conclusion of the study with specific recommendations that could be implemented within the communities of the study area, as well as recommendations for further research to be conducted on the topic.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the characteristics of the *Moringa* plant species are reviewed followed by a brief description of its cultivation. The nutritive value of the plant is reviewed and two countries that have used the nutritive trait of *Moringa* to their advantage are also discussed. Countries globally and in Africa that are interested in *Moringa* are then highlighted and finally, other uses of *Moringa* (apart from its food usage) are given.

The role of traditional leafy vegetables in contributing to dietary quality, dietary diversity and food variety are discussed, as well as the background to the dietary diversity instrument developed by FANTA (2006) and the FAO (2008). Information on the relationship between food acceptability and dietary diversity, as well as the importance of the acceptability of *Moringa* to the Bapedi, is included.

This literature review highlights the link between biodiversity and nutritional health. It focuses on the importance of biodiversity using traditional leafy vegetables viewed as both indigenous leafy vegetables, indigenised leafy vegetables (see Paragraph 1.2) and newly introduced vegetables (see Paragraph 2.4). The nutritional content, the role of plants for improving dietary quality through diversity and cultural food acceptability are discussed (Babu, 2000; Johns, 2003; Kuhnlein 2003; Venter, Jansen van Rensburg, Vorster, van den Heever, and van Zijl, 2007).

2.2 Genus *Moringa*: Characteristics of the plant

As mentioned earlier, *Moringa* is a fast growing tree which can reach 12 m in height at maturity. The stem of the *Moringa* tree is normally straight, but occasionally poorly formed. The tree grows with short straight stems and can reach a height of 1.5 to 2 m before it begins branching out (Rajangam, Azahakia, Thangara, Vijayakumar, and Muthukrishan, 2001). The branches usually grow in a disorganised manner and the canopy is umbrella-shaped. Figure 2.1 shows the growth structure of the *Moringa* tree.

Figure 2.1: *Moringa oleifera* Lam. tree showing stem, leaves and flowers

The leaves are of a compound leaf form, with three leaflets arranged on either side of the stem in pairs opposite each other, growing mostly at the branch tips. The leaves are 20 to 70 cm long with 8 to 10 pairs of pinnae, each bearing two pairs of opposite elliptic or obovate leaflets (Rajangam *et al*., 2001).

Figure 2.2: Leaves of the *Moringa* tree showing compound leaf form

The fruit is a green three lobed pod that hangs down from the branches and can be 20 to 60 cm in length. When dry, it opens into 3 parts. Each pod contains between 12 and 35 seeds (Rajangam *et al*., 2001). The seeds are round, with brownish semi–permeable seed hulls. The hull itself has three wings that run from the top to the bottom at 120 degree intervals. The average weight per seed is 0.3 g. *Moringa* can be cultivated from cuttings and from seeds.

Figure 2.3: Green and dried pods of *Moringa*

2.3 Cultivation of *Moringa*

Moringa grows best in the hot semi-arid tropics. It is drought-tolerant and grows well in rainfalls of 250 to 1500 mm per year (Price, 2000). In the subtropics, *Moringa* can tolerate light frosts. A heavy frost can kill a mature tree back to the roots, but it is capable of recovering. It sprouts fast from the trunk when cut, or from the ground when frozen. According to Price (2000), the *Moringa* tree does well in well-drained sandy or loam soil, but the soil should not be waterlogged. It will tolerate a wide pH range (5-9) and grows quite well in alkaline conditions of up to a pH of 9. It responds well to mulch, water and fertiliser. However it is advisable to prune trees frequently to a shrub to prevent them from becoming lanky and difficult to harvest. The more it is pruned, the bushier it becomes, with more new growth.

2.4 Nutritive Value of *Moringa*

According to Fuglie (2001), *Moringa* has gained popularity as a source of nutrition that can feed the needy and save lives as well. *Moringa* leaves or leaf powder can be used successfully as a complex food to nourish small children, pregnant women and nursing mothers as a treatment for malnutrition. The abundance of vitamin A in *Moringa* can contribute to the treatment of xerophthalmia (night blindness).

Fuglie (2001) and Marcu (2005) reported that *Moringa* leaves have about 40% protein with all of the nine essential amino acids present in various amounts. Because of this, *Moringa* is considered to have the highest protein ratio of any plant studied so far. Vitamin C is found in *Moringa* in large quantities. It was reported that 100 g of *Moringa* leaves contain more than 200 mg of vitamin C and a high content of vitamin A in the form of provitamin A or beta carotene (Fuglie, 2001 and Marcu, 2005).

Table 2.1 presents the proximate composition and content of selected minerals, vitamins and essential amino acids of fresh *Moringa* leaves, pods, and dried leaf powder. Table 2.1 shows that leaves and pods of *Moringa* are rich in minerals and vitamins and could potentially be used in nutritional intervention programmes as a preventive measure against malnutrition. It has been observed that the nutrient composition of traditional vegetables has been recorded using different values, and furthermore unconfirmed data has been recycled in scientific and popular publications (McBurney, Griffin, Paul, and Greenberg, 2004). However, the high nutritional value of *Moringa* is widely recognised. Its value as a source of vitamin A is reported by Fuglie (2001) and as a widely quoted source reported the same data or recycled data, especially vitamin A in terms of 6.8 mg (milligrams) and not as 6800 µg (micrograms). Further confusion in the literature is the expression of vitamin A and beta carotene in International Units (IU).

Ramachandran *et al.,* (1980) reported the vitamin A content of *Moringa* as 11,300 IU per 100 g edible portion. The original source did quote the value as beta carotene, which should read 11,300 IU beta carotene per 100g edible portion (McBurney *et al*., 2004). Babu (2000) reported vitamin A content as 3767 IU per 100 g edible portion. A publication of Kuhnlein (2003) quoted *Moringa* in Niger as containing 5880 µg beta-carotene per 100 g edible portion. This data of Kuhnlein (2000) is recommended by McBurney *et al.,* (2004). An initiative was launched by FAO to analyse the nutrient composition of traditional leafy vegetables so as to standardise the nutrient content per 100 g edible portion (FAO, 2008). *Moringa* with its high value of vitamin A is used as a supplement in feeding programmes (discussed in details in Paragraph 2.6).

Table 2.1: The nutritional value of *Moringa* leaves and pods. (Adapted from Fuglie (2001)

Parameter	Pods	Leaves	Leaf Powder
Moisture (%)	86.9	75.0	7.5
Calories	26.0	92.0	205.0
Protein (g)	2.5	6.7	27.1
Fat (g)	0.1	1.7	2.3
Carbohydrate (g)	3.7	13.4	38.2
Fibre (g)	4.8	0.9	19.2
Minerals (g)	2.0	2.3	-
Ca (mg)	30.0	440.0	2003.0
Mg (mg)	24.0	24.0	386.0
P (mg)	110.0	70.0	204.0
K (mg)	259.0	259.0	1324.0
Cu (mg)	3.1	1.1	0.6
Fe (mg)	5.3	7.0	28.2
S (mg)	137.0	137.0	870.0
Oxalic acid (mg)	10.0	101.0	0.0
Vitamin A – Beta carotene (mg)*	0.11	6.8	16.3
Vitamin B – choline (mg)	423.0	423.0	-
Vitamin B1 – thiamin (mg)	0.05	0.21	2.6
Vitamin B2 – riboflavin (mg)	0.07	0.05	20.5
Vitamin B3 – nicotinic acid (mg)	0.2	0.8	8.2
Vitamin C – ascorbic acid (mg)	120	220.0	17.3
Vitamin E – tocopherol acetate (mg)	-	-	113.0
Arginine (g/16gN)	3.6	6.0	0.0
Histidine (g/16gN)	1.1	2.1	0.0
Lysine (g/16gN)	1.5	4.3	0.0
Tryptophan (g/16gN)	0.8	1.9	0.0
Phenylalanine (g/16gN)	4.3	6.4	0.0
Methionine (g/16gN)	1.4	2.0	0.0
Threonine (g/16gN)	3.9	4.9	0.0
Leucine (g/16gN)	6.5	9.3	0.0
Isoleucine (g/16gN)	4.4	6.3	0.0
Valine (g/16gN)	5.4	7.1	0.0

*** Fuglie reported beta-carotene in terms of mg (milligrams)**

Table 2.2 below shows the contribution in terms of percentage of the FAO/WHO recommended daily allowances (RDA) which is provided by one rounded tablespoon of *Moringa* leaf powder if consumed three times a day by children aged one to three years.

Table 2.2: FAO/WHO recommended daily allowance (RDA) for children 1 to 3 years of age and the nutrients provided by 25 g *Moringa* leaf powder. (Adapted from Fuglie, 2001).

FAO/WHO RDA	% RDA provided
Protein – 16 g	42
Calcium – 400 mg	125
Magnesium – 150 mg	61
Potassium – 800 mg	41
Iron – 10 mg	71
Vitamin A – 1.5 mg*	310
Vitamin C – 20 mg	22

*** Refer to note on Table 2.1**

Fuglie, (2001) recommends that 25 g of *Moringa* leaf powder equals one rounded tablespoonful of *Moringa* leaf powder which when added to infants' food three times per day would provide roughly the RDA percentages in Table 2.2 with calcium and vitamin A 1.5 mg or 1500 µg exceeding the RDA by 310%.The vitamin A intake for the group children 1-3 years in South Africa was less than one out of two 55-66% that was half the recommended level (Labadarios, 2000). The vitamin A intake for children living rural in the age groups between 1-9 years was 62-73%. At national level less than one of two 55-68% children had a vitamin A intake that was half the recommended level (Labadarios, 2000). This secondary information are important for setting the criteria for the third cyclical phase in the field research (see Paragraph 3.3.1)

The fresh leaves of *Moringa* can be used in dishes to increase the variety of nutritious food items in the diet (see Paragraph 2.8). Alternatively *Moringa* can be used as a dried leafy powder added to dishes as a food-based supplement to enrich food by means of adding nutrients.

2.5 The use of *Moringa* in countries outside Africa

According to Rajangam (2000), more than two million homesteads make use of *Moringa* daily in India. As a result, a number of studies have been conducted on the plant, including some studies on the commercial propagation of *Moringa.* Propagating *Moringa* commercially has been boosted by the availability of good quality seeds developed by scientists at a horticultural college and research institute in the south of India (Nambiar, 2006). In addition to cultivating *Moringa* for commercial purposes, the state of India aims to introduce Dehydrated Drumstick Leaves (DDL) into diets of vitamin A-deficient children as a nutritional intervention strategy through their supplementary feeding programmes (Nambair, 2006; Nambair and Seshadri, 2001).

In the United States, Palada (1996) suggests southern Florida and Miami as the sub-tropical regions where *Moringa* can be grown successfully. Palada recommends research into cultivating the plant and processing it into various goods for export purposes.

Studies of botanical notes in Mandarin by Jahn (1996) showed that *Moringa* was introduced by Indians and Malaysians to some communities in China (Macao Territory). From China the plant was transferred to other communities as well. Noting the versatile use of *Moringa*, Jahn (1996) suggested extensive education on the plant and the introduction of better cultivation practices for better yields.

Other countries in which *Moringa* has become naturalised are Thailand, Singapore, the West Indies, Mexico and the Philippines (Fahey, 2005; NRC, 2006). It has also been naturalised in countries in Africa and has become indigenised as a food source in some African dietary patterns.

2.6 The use of *Moringa* in Africa

Intervention programmes have been implemented based on research to promote the use of *Moringa* as a traditional leafy vegetable to improve nutritional health in Africa. The WHO and the International Consultative Group on VAD declared in 2000 that Malawi had serious VAD among its population compared to other countries in Southern Africa (Babu, 2000). Intervention programmes that the government of Malawi embarked on for combating VAD included horticultural crop production, vitamin A supplementation and agricultural extension (Babu, 2000). Most of these efforts made little progress until government agencies recognised the importance of using indigenous plant foods in trying to solve the nutritional disorder of VAD and the need to incorporate them into its policies.

Eventually, the Food and Nutrition unit in the Ministry of Agriculture identified nutrient–rich *Moringa* that commonly grew in several parts of Malawi as a potential solution to VAD deficiency (Babu, 2000). The identification programme was conducted by comparing the nutrient content of seven plant foods with a high content of vitamin A which are commonly consumed in Malawi to *Moringa* (Table 2.3). *Moringa* had the highest content of vitamin A and appreciable levels of vitamin C, protein, phosphorous and calcium (Babu, 2000).

Table 2.3: The nutrient content of leaves of common relish foods in Malawi compared to *Moringa* (per 100 g edible portion) Babu, 2000

Nutrients	Beans	Cowpea leaves	Turnip leaves	Cassava leaves	Amaranthus leaves	Pumpkin leaves	Moringa leaves
Energy (Kcal)	320	45	35	90	45	25	95
Protein (g)	22	4.7	2.9	7.0	4.6	4.0	6.7
Phosphorous (mg)	95	63	130	1230	100	135	70
Vitamin A (IU)	85	389	708	1667	1278	556	3767
Vitamin C (mg)	25	56	62	310	50	80	220
Calcium (mg)	22	225	160	300	410	745	440

According to Babu (2000), a model was then designed for introducing *Moringa* to the people of Malawi. This model later became a general framework for rural nutrition intervention programmes with indigenous plant foods. The following steps were identified in the framework:

- Problem identification
- Making an inventory
- Analysis and screening
- Acceptance analysis
- Developing cropping practices
- Extension and training
- Evaluation.

During the acceptance analysis in the Malawi research, four different recipes of *Moringa* were tested by 50 rural households, alongside boiled pumpkin leaves. Sixty-three percent of the participants preferred *Moringa* leaves to pumpkin leaves, and 70% of the participants indicated their interest in learning the recipes using *Moringa* in their regular diets. Babu (2000) and Venter *at al.,* (2007) reported that South African leafy vegetables were analysed. Pumpkin leaves (*Curcurbita*), amaranth (*Amaranthus*) and cat whiskers (*Cleome*) were found to be recommended for adding to the diet to

alleviate micronutrient and PEM. Factors that influence the nutrient content and bioavailability are maturity of leaves with harvesting, part of the plant utilised, fertiliser used, post harvest handling, preparation time and temperature (Venter *at al.,* 2007).

In Senegal, Church World Service (CWS) in Dakar together with Alternative Action for African Development (AGADA) embarked on a pilot project in 1997 to find answers to several questions regarding the value of *Moringa* and public reaction to its use (Fuglie 2001). The pilot project was to test the theory that "*Moringa* products if added to an individual's diet on a regular basis could prevent or cure malnutrition" (Fuglie, 2001). Government health workers (doctors, nurses, mid-wives) were trained in ways of using the plant, taught how to recommend it to their patients and how to keep records of results. In addition, the personnel of CWS and AGADA put together informational booklets and brochures on *Moringa.* Seminars on *Moringa* were also held and, finally, advertisements on the plant were broadcast on radio.

The health workers who were trained (being nurses specialising in paediatrics) collected the *Moringa* leaves, dried them and kept the dried leaf powder on hand to distribute to mothers of malnourished children. Records were kept, including photographs of children who recovered from malnourished states through the addition of *Moringa* to their diets. In 1998, an external evaluation of this project concluded that it had been very successful. One reason for this was that *Moringa* grew wild in Senegal and therefore was not expensive to acquire. Many of the classical approaches to treating malnourished children were expensive because they depended on imported solutions and outside personnel. On the other hand, with *Moringa*, the resource was locally available (Fuglie, 2001).

In Niger, *Moringa* is cultivated as a cash crop as well as a food source (Sauveur and Hartout, 2001). It is considered a wild plant that is readily available when there is plenty to eat as well as in times when no green vegetables are available (Freiberger, Vanderjact, Pastuszyn, Glew, Mounkaila, Millson and Glew, 1998; Sena, Vanderjagt, Rivera, Tsin, Muhamadu, Mahamadou, Millson, Rastuszyn, and Glew, 1998). Two studies were done to determine the mineral, amino acid and fatty acid contents of the leaves of seven wild plants and also of eight famine foods of Niger respectively (Freiberger *et al.*, 1998 and Sena *at al.*, 1998). Of the seven wild plants that were studied, *Moringa* leaves were found to contain the highest overall protein quality in comparison with the WHO protein standard (Freiberger *et al.*, 1998). On the other hand the study of the eight famine foods found *Amaranthus virdis* as the plant with the highest source of protein and not *Moringa* (Sena *at al.*, 1998). This is because all their samples were sun-dried; but to obtain the maximum output of *Moringa,* it should be dried indoors and not in direct sunlight, since sunlight destroys vitamin A (Fuglie, 2001).

To treat micronutrient malnutrition in Tanzania, a project was established to develop food products from soya beans and *Moringa* leaves to feed pre-school children, pregnant and lactating mothers and people living with HIV/AIDS (Rweyemamu, 2006). The challenges were that different processes produced products with different sensory characteristics. This project is on-going and is working together with Dar es Salaam Functional Foods and Nutraceuticals Cluster to get the product to the community (Rweyemamu, 2006). Tanzania also cultivates *Moringa* for oil production and for water treatment (NRC, 2006).

In Benin and Togo, projects were implemented in which *Moringa* was and is still being cultivated for its leaf powder for commercial purposes. This is mainly done by women and an income is usually generated (Sauveur and Broin, 2006). According to Saveur and Broin (2006), the most encouraging part is that more and more farmers are joining in the planting of *Moringa.* Pilot studies involving the incorporation of *Moringa* in infant cereal have been undertaken in Togo (Sauveur and Broin, 2006). *Moringa* was added to local ingredients (flour mixtures) in varying percentages to produce infant formulas. These formulas, which ensured a balance daily intake of calories in proteins, lipids and carbohydrates were subjected to sensory tests by 53 children aged between 6 and 30 months. The acceptability of the formulas amongst the babies was encouraging as “all the mothers accepted all the flour mixtures, all of the children accepted the cereal with a 10% *Moringa* content, 3 of the 53 children refused to eat the cereal with a 15% *Moringa* content and 5 of the 53 children refused the cereal with a 20% *Moringa* content”. The use of *Moringa* leaves to enrich infant formulas was therefore found to be theoretically possible and further research was recommended (Sauveur and Broin, 2006).

In the north-eastern part of Nigeria, a hundred households were surveyed for their use of edible wild plants. These plants, which were usually consumed during the dry season were analysed for protein, fat, carbohydrate and their mineral content. Some of the plants, including *Moringa,* were found to be good sources of protein (Lockett, Calvert and Grivetti*,* 2000). Other African countries that make use of *Moringa* as a food source are Cameroun, Chad, Ethiopia, Ghana, Kenya, Mali, Somalia, Sudan and Zimbabwe (Fuglie, 2001).

2.7 Other uses of *Moringa*

Apart from *Moringa* leaves and pods being used as food for human consumption, there are other uses of the *Moringa* tree.

2.7.1 Green manure and plant hormone

Moringa could be used as green compost. The juice from the fresh leaves can be used to produce an effective plant growth hormone (Price, 2000; Foidl, Makkar and Becker, 2001). This hormone increases the yield by 25 – 30 % for nearly any crop including onion, bell pepper, soya, maize, coffee, tea and other plants. The active substance is zeatin; a plant hormone from the cytokinines group, which is available as a spray.

2.7.2 Fodder

Moringa leaves are used as feed for cattle, pigs and poultry. When *Moringa* leaves constituted 40 to 50% of feed, it was found in research studies that milk yields for dairy cows and daily weight gains for beef cattle increased by 30%. The birth weight of calves increased by 3 to 5 kg. Some animals, such as chickens will not voluntarily consume *Moringa* leaves or *Moringa* leaf powder (Price, 2000). However, about half the protein content can be extracted from the leaves in the form of a concentrate which can then be added to chicken feed. The protein content desired in chicken feed is 22%. To obtain the concentrate, leaves are mixed with water and the mix run through a hammer mill. The resultant mash is heated to 70°C for 10 minutes. The protein coagulates and settles at the bottom. After pouring off the supernatant liquid, the coagulated protein can then be freeze-dried (Price, 2000).

2.7.3 Seed oil

The oil from the seeds of *Moringa* is of a high quality and can be used as a lubricant and also in cosmetics and perfumes (Fuglie, 2001; Roberts, 2007). The *Moringa* oil can be extracted in the home (Fuglie, 2001). Seed from mature pods are roasted, mashed and placed in boiling water for five minutes. After straining and being left to stand overnight, the *Moringa* oil floats to the surface.

Figure 2.4: Dehulled seeds of *Moringa*

2.7.4 Water purification

The seed powder of *Moringa* is used to purify turbid water (Foidl *et al.,* 2001; Jahn, 1998). This usage of *Moringa* has encouraged a lot of research and has been proved to be an inexpensive method of treating water (Okuda, Baes, Nishijima and Okada, 1999; Ndabigengesere and Subba, 1998; Warhurst, McConnachie and Pollard, 1996*;* Ghebremichael, Gunaratna, Henricksson, Brumer and Dalhammar, 2005; Okuda, Baes, Nishijima and Okada, 2001). The seeds are prepared for use as a coagulant by removing the seed coats and the wings. The white kernel is then crushed to a powder either using a mortar or by crushing it with a stone between cloths. Two heaped teaspoons of the powder are mixed with a small amount of clean water in a bottle. This is then shaken for five minutes to form a paste. The paste is then stirred rapidly for two minutes, and then slowly for 10 -15 minutes. The bucket of water is then left undisturbed for at least an hour. This will make all the impurities sink to the bottom. The water is finally strained and stored in clean containers. This process removes 90 to 99% of impurities from the water (Price, 2000).

2.8 Dietary quality and the use of traditional leafy vegetables

Of an estimated several thousands of plants, approximately seven hundred have been traditionally used for food. At present maize, wheat and rice account for 60% of the total energy intake of the diet. This tendency to rely on three main crops in agriculture has led to a decline in consumption of more diverse grains and an accompanying decrease in the variety of vegetable and plant species consumed (Johns, 2003). The neglecting of species and their conservation is referred to as a decline in biodiversity (Kuhnlein 2000). An additional tendency is for the young to associate traditional or indigenous foods with being backward, which leads to their not retaining the practices and uses associated with it. This tendency is causing a disruption in dietary patterns and loss of dietary diversity, leading to lower quality diets in most areas of the world (Johns, 2003).

The NFCS (1999) for children between the ages 1>9 years in South Africa provides a scenario within which to view the value of the study. Children of all age groups in rural areas had a consistent and significantly lower energy intake than children living in urban areas. At national level less than one out of two 55-68% children had a vitamin A intake that was half the recommended level. A similar pattern 62-73% for vitamin A intake is found in the rural areas. In Limpopo Province one of three children of all age groups studied had less than half of their daily energy needs met. Results on vitamins and minerals did indicate any improved situation. The consumption, food acquisition and household food inventory results reflect a high energy intake from maize and sugar and brown bread. Subsistence agriculture was found not to be a major source of most of the food items consumed of plant or animal origin. The consumption of vegetables was low and used mainly as a potherb in stews or relishes two to three times a week.

2.8.1 The use of traditional leafy vegetables in South Africa

The role of wild or traditional leafy vegetables in nutrition is recognised in Africa. Influences over two thousand years have changed food consumption patterns considerably; specifically in terms of the use of modern food crops which provide energy in the diet. In this process of change the displacement of traditional leafy vegetables has increased micronutrient deficiency (Modi, Modi, and Hendricks, 2006; Jansen van Rensburg, *et al*., 2007).

In South Africa Wehmeyer and Rose (1983) identified more than a 100 different species of plants that were being used as leafy vegetables. The traditional leafy vegetables species are referred to collectively as *Morogo* (isiPedi) or *imfino* (isiZulu and isiXhosa) by African people in South Africa (Jansen van Rensburg *et al*., 2007). The collective concept *Morogo* as traditional leafy vegetables of

the Bapedi is an important concept in the study of contemporary indigenous knowledge and practice. These species can be associated with biodiversity, the dietary patterns of the African people and change over time determining the dietary pattern of the contemporary communities. These species may be indigenous or indigenised species collected from the wild, or cultivated in fields where some grow as weeds, the limited broadcasting of seeds from selected species, and the limited number of species being cultivated, as well as recently introduced plant species in cultivation (Jansen van Rensburg *et al*., 2007; Hart and Vorster, 2006).

The use and consumption of traditional leafy vegetables in South Africa are widespread, although they have decreased among rural people in the last two decades (Hart and Vorster, 2006; Modi *et al*., 2006). Jansen van Rensburg *et al.,* (2007) quote from research studies by Schackleton and other authors in Limpopo, the Eastern Cape and KwaZulu-Natal that traditional leafy vegetables were harvested from the wild and used mainly for homestead consumption. The harvesting of traditional leafy vegetables was the highest in Limpopo Province and the lowest in the Eastern Cape Province. The products found in markets are grown by smallholder farmers and are either cultivated under irrigation or restricted to dried products sold by petty traders (Van Averbeke, Tshikalange and Juma, 2007). The two main methods of drying are the sun-drying of fresh leaves or the sun-drying of blanched or cooked leaves with a long shelve -life. The electrification of rural areas has introduced new preservation technology, including the blanching and freezing of leaves (Van Averbeke *et al*., 2007).

Traditional leafy vegetables are associated with poverty, the past and low self-esteem, in particular in the eyes of the youth and urbanised communities (Jansen van Rensburg *et al*., 2007). However rural Africans still hold indigenous knowledge of traditional leafy vegetables. This knowledge is associated with the female domain in South Africa. However once grown as a crop, the male domain becomes interested as such crops are commercialised (Hart and Vorster, 2006). The decline in poor utilisation may also be associated with the lack of knowledge of how to access quantities and employ practices that can satisfy daily nutrient requirements. The interest in traditional leafy vegetables by researchers and policy-makers contrasts with the extent of use and consumption of traditional leafy vegetables by communities (Jansen van Rensburg, *et al*., 2007).

The traditional Bapedi diet and traditional leafy vegetables have been described by Quinn (1959). Several species have been identified and reported by Masekoameng, Ferreira and Molotja (2003), Jansen van Rensburg, *et al*. (2007) and Venter e*t al.* (2007) as contemporary commonly consumed traditional leafy vegetables which are in use. Some species commonly consumed in contemporary South Africa are amaranth (*Amaranthus spp*), spider flower (*Cleome gynandra*), Chinese cabbage

(*Brassica rapa* subsp. *chinensis*), nightshade (*Solanum retroflexum* and other selected species belonging to the *S. nigrum* complex), Jew's melon (*Corchorus olitorius* and *C. tridens*), cowpeas (*Vigna inguiculata*) and pumpkins (*Cucurbita pepo, C. maxima* and *C. moschata*), melons (*Citrullus lanatus* and *Cucumus melo*) and other selected indigenous cucurbits, such as balsam pear (*Morordica balsamina*) (Jansen van Rensburg, *et al*., 2007). Each of these species has names in the local vernacular in South African communities. The food composition of all these species has been analysed.

Venter e*t al.,* (2007) reported that South African traditional leafy vegetables were analysed by the Univeristy of Pretoria and the Agricultural Research Council (ARC). Pumpkin leaves (*Curcurbita*), amaranth (*Amaranthus*) and cat whiskers (*Cleome*) were recommended for adding to the diet to alleviate deficiencies and PEM. Factors that influence the nutrient content and bioavailability are the maturity of the leaves with harvesting, the part of the plant utilised, the fertiliser used, post harvest handling, preparation time and temperature (Venter *at al.,* 2007).

In summary, in South Africa and in Africa as a whole, local grain crops, roots and tubers, leafy vegetables and wild fruit occupy an important place in traditional diets (Johns, 2003; Jansen van Rensburg *et al.,* 2007; Venter *et al*., 2007). Traditional food systems have enabled traditional people to develop a kind of wisdom of their own who realise the importance of diversity without knowing the specific nutrients in individual foods in the diet which contribute to health (Johns, 2003; Kuhnlein, 2003). Dietary quality studies of traditional food systems can be strengthened by the scientific analysis of the nutrients in foods which have not yet been analysed.

2.8.2 Dietary quality

A discussion of dietary quality, dietary diversity, dietary variety and nutrient adequacy requires a description of the terms used. Ruel (2003) argues that she has found no official definition for *dietary quality*, a term that has been historically associated with nutrient adequacy. *Nutrient adequacy* refers to diets that meet the nutritional requirements or recommended levels for energy and all essential nutrients. The transition or change in diets in certain countries, or those moving towards transition, has resulted in a decrease in variety and an increase in more refined and processed foods. These developments have led to the inclusion of nutrient deficiency and overnutrition in the description of dietary quality (Ruel, 2003).

Nutrient adequacy can be associated with the achievement of recommended intakes of energy and essential nutrients. The nutrient adequacy ratio (NAR) is the ratio of intake of a particular nutrient to its RDA, usually calculated at 100% of the RDA (Ruel, 2003). Measurement tools to measure nutrient adequacy are related to dietary diversity and dietary variety, which are proxies for dietary quality (Ruel, 2003). Variations of these approaches and the analysis of dietary diversity for nutrient adequacy have been carried out in different countries and are described in the literature (Ruel, 2003). However these issues will not be discussed extensively in this review, except by means of reference to a few examples.

2.8.3 Dietary diversity and food variety

Ruel (2003) describes *dietary diversity* as the number of different foods or food groups consumed over a given reference period. *Dietary variety* or *food variety* are terms often used in the literature and refer to different foods or the variety score as a simple count of food items. Ruel (2003) considers *dietary variety* as synonymous with *dietary diversity*. Dietary diversity is also measured as a variety score among major food groups or a variety score within major food groups.

In Mali (Hatlóy, Torheim and Oshaug, 1998) a study was carried out which specifically validated dietary diversity. This study used the food variety score FVS (a simple count of the number of foods) and the dietary diversity score DDS (a simple count based on eight food groups) and compared it with the mean adequacy ratio for nutrients. The correlation coefficients between nutrient adequacy and FVS (0.33) and DDS (0.39) were associated with a greater percentage of energy from fat, and a higher density of vitamin C and vitamin A in the diet. The contribution of the findings of this study is that it has shown that the dietary diversity score based on food groups is a stronger determinant of nutrient adequacy than a food variety score based on individual foods. Dietary diversity is a simpler and easier to use method, with advantages to be gained in developing areas in surveys under field conditions (Ruel, 2003).

According to FANTA (2006), “To better reflect a quality diet, the number of different food groups consumed is calculated, rather than the number of different foods consumed”. Most often dietary diversity measures consist of a simple count of foods or food groups such as the HDDS measurement developed by FANTA (2006) and validated by the FAO (2008) publication. Dietary diversity can be measured by calculating the number of foods or food groups consumed over a period, say, of between one and three days; seven days is often used, as well as periods of up to 15 days (Ruel, 2003). Using

specific measurements for these calculations has the advantage of allowing a comparison of results within and across countries.

2.8.4 Dietary diversity and food variety scores

A strong relationship exists between dietary quality and dietary diversity in developing countries (Ruel, 2003). The validated HDDS (FANTA, 2006) uses 12 food groups and a variety score of one for each food group (see Appendix B). The traditional five food groups are divided into sub-groups for those food groups, including food items with a higher vitamin and mineral content. The HDDS is ranked from one to twelve scores for the twelve food groups. The higher the score, the more diverse the household diet is.

In studies in Mali (Hatlóy *et al*., 1998) and Kenya (Onyango, 1998) dietary diversity was positively identified, with stunting in children associated with micronutrient deficiency. The Mali study referred to above used a cut-off point for each of the two indicators, six for DDS and 23 for FVS, which provided the best sensitivity and specificity combinations for predicting nutrient adequacy. In the Kenyan study the diversity score as number of foods was five. A score higher than five was found to be more important for growth among children not breastfed and a positive association with certain nutrients. Ruel (2003) summarises from six different studies in table form that a DDS of five and more could provide a diet adequate in nutrients.

In Mozambique (Rose *et al.,* 2002) a diet assessment tool was developed based on the principles for the FVS, but using a score of four for each food item, depending on factors such as nutrient density, bioavailability, and foods consumed in smaller or larger amounts, as well as three categories with different cut-off scores for dietary variety to indicate dietary diversity. The dietary variety was scored using four as the maximum score for each food item. One could argue that a mean score simplified from four to one, then a score of 12 and below (mean of three) indicated very low dietary quality, 12-19 (mean score of above both three and four) indicated average dietary quality and 20 or more (mean score of five and more) indicated an adequate diet. This calculation estimates that five could be a critical value in diets with limited food items, if the items represent each of the twelve groups, as in the HDDS (FAO, 2008).

According to Ruel (2003), cut-off points need to define the varying levels of diversity in the context in which they are used, taking into account the local food system and dietary pattern. In each context the set of foods and food groups that can contribute to improving dietary quality should be defined; therefore cut-off points should be locally defined. Similarly, the selection of food groups should be driven by the specific purpose of the dietary diversity indicator to be used (Ruel, 2003).

A study by Steyn, Nel, Nantel, Kennedy and Labadarios (2005) on dietary diversity and food variety scores in South African children identified the cut-off point for the DDS as four (using nine food groups) and the FVS as six. These cut-off points provided the best sensitivity and specificity for the micronutrient adequacy of the diet and therefore significant correlations between both height for age and weight for age. Both scores indicated a strong relationship between dietary diversity and the indicators for growth. These cut-off points provided positive predictive values for the mean adequacy ratio for nutrients above 50%. A mean adequacy ratio for nutrients of 70% could be provided by a DDS of four and an FVS of 11. The NAR was calculated using the Agricultural Food Organisation/World Health Organisation's recommended intakes for children (Steyn *et al*., 2005).

2.8.5 Socio-economic factors and dietary diversity

Studies reviewed by Ruel (2003) found consistent associations between dietary diversity and the various indicators of food consumption and food availability which were used. The authors quoted are of the opinion that dietary diversity holds promise as a means of measuring food security, especially in field research where resources are limited. The study by Hatlóy *et al*., (2008) tested the association between dietary diversity and socio-economic status, using DDS, FVS and measuring 14 assets. The low socio-economic group scored 2-3 assets, the middle group 4-6 assets and the higher group 7-10 assets. The dietary diversity increased with an increase in socio-economic status, both in urban and in peri- urban areas. A larger diversity was found between urban and traditional households, and a higher dietary diversity was found even amongst the lowest urban groups. The association between dietary diversity and socio-economic status was also found in a number of other studies which Ruel (2003) included in the review. When assessing dietary diversity and nutritional outcomes, it is important to take into account household socio-economic characteristics. Dietary diversity can also be used as a proxy for socio-economic status.

In summary for this study the cut-off point or critical value of four for the HDDS will reflect that a household consumes an average of four of the twelve food groups in a 24 hour recall period. This indicates that the macronutrient and micronutrient needs of that household may be supplied. Socio-economic characteristics have to be considered in sampling. The HDDS was used in this study to determine the dietary diversity of the households including all the groups of women who were interviewed from the various communities.

2.9 Acceptability of *Moringa* as a traditional leafy vegetable

The cultural acceptability of food in the dishes in which it is used is an important factor for its local acceptance and adoption in the diet (Kuhnlein, 2003). Selecting food from rural communities and determining the taste potential, that is whether it can be utilised as a source of raw food using culturally acceptable methods of preparation, may create awareness and acceptance. It may also promote nutritious foods from childhood upwards or by means of adding supplementation (Venter *et al.,* 2007).

The final part of this study reports on the investigation into the acceptability of *Moringa* as a green leafy vegetable to be incorporated into the traditional diets of the Bapedi community. Understanding taste preferences may lead to more successful acceptance of micronutrient-rich vegetables and fruits. People eat food that satisfies in appearance and taste as well as meeting their nutritional requirements, religious and cultural values, psychological and social needs and budget (Brown, 2000). People also evaluate food based on how it looks smells, tastes, feels and even sounds. These sensory factors are more important to most consumers in making choices than nutritional considerations (Brown, 2000). When the quality of food is judged or evaluated by the senses (taste, smell, sight, touch and hearing), this is said to be a sensory evaluation. Since the primary purpose of preparing food is to eat and enjoy it, the use of sensory evaluation to determine the acceptance of any new dish is very important (Bennion, 1995; Drewnowski, Henderson, Levine and Hann, 1999).

Studies in cultural acceptability have often used focus groups for preference tests without any training or experience of sensory evaluation. This strategy can be referred to as the affective testing of the acceptability of food which involves the subjective factors of food preferences or in simple terms, the likes or dislikes of food on a hedonic scale, requiring a response from one to five, one to seven or one to nine. A low value indicates an extreme dislike, whilst high values indicate an extreme preference (Den Hartog *et al.,* 2006). Participants can either be requested to evaluate the complete product or to assess the different sensations of taste, smell, sight and mouth feel. This kind of sensory evaluation is

usually used to indicate a preference for the same type of food. These studies are often referred to as consumer testing, where untrained panels and smaller groups can be used to gain insight into preference, and possible acceptability.

Food preferences are indicative of the current diet. The possible acceptance of a future selection of new foods that are high in micronutrients is indicative of a change in dietary quality. A study by Drewnowski *et al.,* (1999) found associations between food preferences and nutrient intakes, but also saw that the possibility of using food preferences as a proxy for dietary intake. Further research is needed to demonstrate the influence of taste factors on dietary outcomes. Preferences for green vegetables and orange carotene-rich foods are associated with higher intakes of beta carotene (Drewnowski *et al*., 1999). Studies reported in Paragraph 2.6 have also highlighted the importance of food preference testing and the acceptability of food to a specific group.

Jansen van Rensburg *et al.,* (2007) describes the popularity of species of traditional leaf vegetables as involving factors including availability, ease of preparation, taste, consistency and appearance. Soft, fast-cooking leaves are preferred to the more fibrous leaves which require longer cooking times and which are subject to regional and gender diversity. Usually it is the young and tender leaves which are harvested and cooked by means of boiling. South African communities in the north enjoy bitter tastes and a mucilaginous texture, while in the south sweet tastes are preferred and there is a dislike for sliminess (Voster *et al.,* 2007 and Jansen van Rensburg *et al.,* 2007*)*. The introduction of *Moringa* as an indigenous African leafy vegetable, then, is a challenge in this study and may coincide with the traditional sensory characteristics preferred by the Bapedi in the north, which is in Limpopo Province.

2.10 Summary

The literature review has provided background information on the three main conceptual issues, namely *Moringa* and the nutritional value of leaves of traditional plants, dietary quality and food acceptability. The information on *Moringa* has informed the development of the interview schedule on *Moringa* and was used for validation purposes whilst conducting the interviews with the Indian respondents and holding the focus group discussions. Similarly the interview schedule and focus groups were used to collect information on the Bapedi traditional green leafy vegetables, dietary quality and dietary diversity, with its associated standardised instrument which formed a section in the interview schedule. Testing food acceptability using a hedonic scale was also used. This review also provides evidence from secondary sources which focus on the research methodology in particular.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In any research on indigenous foods for their future promotion, the methodology should include methods which address the need for local participation, which respect and make provision for the local culture and circumstances; the possible need to work in the local language and the requirement for local capacity building which assists possible ventures (Kuhnlein, 2003). Kuhnlein (2003) also states that individual interviews of community members and focus group discussions are two of the steps that could be conducted in research on indigenous knowledge and that promote activities which can improve a community's micronutrient status. The use of groups or focus groups is grounded in action research and social learning (Lewin, 1948).

In this chapter, a description of the study area and the study population is provided. These are followed by a description of the scoping visit to and observe the research area, as well as the piloting and data gathering visits. The chapter further documents the details of the research method in terms of sampling, data collection and data analysis techniques that were used. Ethical considerations are also discussed and finally the constraints faced during the data gathering.

3.2 The study area

The study was conducted at Mokopane (previously known as Potgietersrus) in the Limpopo Province.

3.2.1 Scoping and observation visit

The scoping of Mokopane as a potential study area was initiated by personal communication with a vendor who sells *Moringa* at a street market in Pretoria. The scoping and observation visit to Mokopane took place in October 2007 and the following observation criteria were set:

- Agro-ecological classification of the area
- Distribution of *Moringa* plants presence of potential knowledge holders of *Moringa*
- Similar location of peri-urban and traditional Bapedi populations.

In terms of these scoping and observation criteria the following results were deciding factors in selecting Mokopane as the study area.

The climate is semi-arid, with moderate winter temperatures and is warm to hot in summer (Verbeek and Lomberg, 2005). The majority of the 350 – 400 mm average annual rainfall occurs in the months of November to March.

Through personal communications *Moringa* trees were found to be growing prolifically in an urban Indian community, who are known to utilize *Moringa* in their diets. Literature revealed that Limpopo Province has the highest rate of VAD in young children younger than five years of age (see Chapter 1 Paragraph 1.2.2.1 and Figure 1.1) and could therefore potentially be an ideal location for the testing of acceptability of an alternative vitamin A rich food source such as *Moringa.* The presence of two Bapedi communities, one peri-urban and one traditional, situated in Mokopane necessitated further investigations to establish whether their dietary diversification were in need of food-based supplementation, their role as social leaders (peri-urban) and participants in social groups (traditional) and therefore determining their potential interest to introduce *Moringa* in their diets.

The peri-urban Bapedi community lives on the periphery of Mokopane. The traditional Bapedi community lives near Mokopane as well as in a location about 15km from the centre of the town and is managed by the local tribal authority and the local government. This community practises homestead farming with home gardens around each homestead. The community is therefore not referred to as a rural community but the term traditional is used for the remainder of the study. The traditional Bapedi participants were selected from five villages named Moshate, Masodi, Maroteng, Masehlaneng and GaMadiba.

3.2.2 The piloting visit

A preliminary exploratory study as suggested by Strydom and Venter (2002) was conducted. During the piloting visit five households from the Indian community were chosen for the pilot study. Upon entering the community the first household with a *Moringa* tree was approached as access point for the purposive sampling. Strydom and Venter (2002) propose that judgment of the researcher determines the purposive sample as composed of the elements that represent the most attributes of the population. In this case the attributes were the presence of a *Moringa* plant coupled with the assumption that the household would be utilizing the plant. The person responsible for the food preparation was then interviewed. According to Lewin (1948) these food managers are the gatekeepers for the household food decisions. The purpose of the interview was foremost to pilot the

interview schedule (Appendix B) and secondly to gather the necessary information in order to plan the main data gathering visits in terms of the practicality of data gathering, the details for the completion of the interview schedules, as well as gaining access to communities through correct authorities and tribal rules.

During the first interview, information came to light which resulted in the adaptation of the interview schedules which had been drawn up for use in the main study. It was found that the Indian community consisted of mainly two groups of Indians, one group comprised those individuals who had grown up in India and now resided in South Africa and the second group was those individuals who had grown up in South Africa. The Indians who had grown up in India consumed both the leaves and the pods of *Moringa* whilst those who had grown up in South Africa consumed mainly the pods. This indicated a potential variation in the utilization patterns of the knowledge holders of *Moringa*. This variation did not have an adverse effect on the study other than providing variations in indigenous knowledge applications. The observation also revealed that most of the Indian women were housewives and could be interviewed during the day. Due to social conventions random sampling was not possible. Strangers are not freely allowed into homes so it was also not possible to invite strangers as part of a focus group to one of the interviewee's home. An extended family therefore agreed to participate in the focus group discussion.

As part of the piloting visit a contact person in Pretoria referred the researcher to a community leader in the peri-urban Bapedi area, through which contact was made to get access to households who are members of various social groups in the peri-urban Bapedi community. Finally, with the assistance of the community leader in the peri-urban area, the researcher was introduced to the headman of the rural Bapedi community. Permission was sought from the headman in charge of the local villages to proceed with the research. Arrangements were made to visit a group of senior women who were related to the tribal chief, to ask them to assist in identifying some social organisations. Mothers with children below the age of ten living in five villages who had some relationship to a social organisation, such as the funeral society and the church society operating within the tribal area were selected to be interviewed during the main data gathering visit. This group of women also assisted in identifying the facility used by a community organisation, a crèche and a residence next to the clinic which was a suitable venue for the interviews. The local government office gave permission for the researcher to interview a select group of mothers as a point of access to the community. The facilities of the crèche were to be used to prepare the dishes, using *Moringa.*

3.2.3 Data gathering visit

Due to the action research participatory paradigm of this study as discussed in paragraph 1.5 quantitative and qualitative investigations were undertaken. This necessitated the main data gathering visit to have taken place during two visits. The gathering of indigenous knowledge of *Moringa,* utilization of the Indian group (objective 1) as well as the peri-urban samples, diet diversity and traditional leafy vegetable usage (half of research objectives 2, 3 and 4) were conducted during November 2007. The traditional community was visited in April 2008 during which time their diet diversity and traditional green leafy vegetable use was assessed (second half of research objectives 2, 3 and 4). During both these visits the *Moringa* plant was in full bloom.

3.3 Research design and methodology

The research design is defined by Mouton (2001) as "a set of guidelines and instructions to be followed in addressing the research problem". Mouton (2001) also explains that a research design mainly enables the researcher to anticipate the appropriate research decisions so as to have valid results at the end of the research. The research design was discussed in paragraph 1.5 in terms of the philosophy, paradigms and typologies that this research subscribes to.

Based on the preparations that were made during the scoping and observation visits as well as the piloting visit, the research methodology that was used during this study is documented below.

3.3.1 Research framework

Mouton (2001) suggests a number of advantages to using a flow diagram or framework that depicts the various tasks associated with each stage of the research. This exploratory study in which the use of indigenous knowledge coupled with nutritional issues, are depicted within an action research approach (Figure 3.1) as suggested by Kuhnlein (2003), which in this study documents indigenous knowledge of *Moringa* utilisation by starting with interviewing key persons or knowledge holders and verifying and triangulating the data using focus group discussions. This allows for development of an action research spiral within each sample which follows sequential stages so as to assess the dietary diversity of participants, discover the indigenous knowledge from the knowledge holders and the acceptability of the leafy vegetables (Lewin, 1948). The process followed a reflective cyclical process (reflect-plan-act-observe) as shown in Figure 3.1.

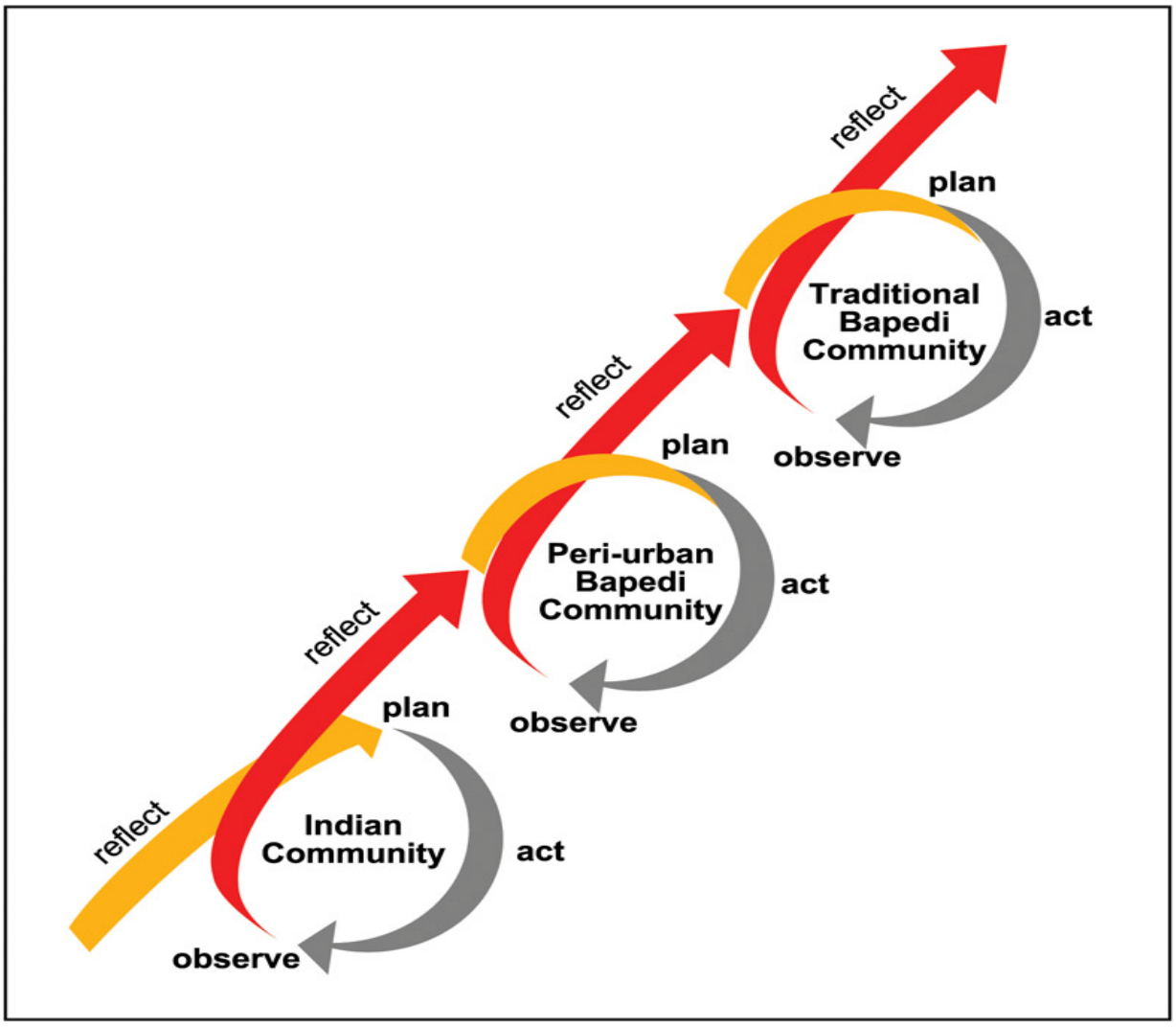

Figure 3.1: Action research approach spiral (Adapted from: Higher Education Academy, 2002)

The process illustrated in Figure 3.1 involved moving from the Indian area towards the Bapedi peri-urban community and then on to the traditional Bapedi community. Both of the Bapedi communities can benefit from this kind of research action and simultaneous learning which strengthens the use of or possible adoption of a nutritious leafy vegetable that could be introduced to them. The process and each cycle were guided by the adoption of a highly nutritious leafy vegetables could to enrich the diet with micro-nutrients, whilst at the same time respecting their present indigenous knowledge and dietary behaviour (Kuhnlein, 2003).

The action research approach spiral is used as the foundation for designing the research framework as shown in Figure 3.2. The sampling, data gathering and associated research objectives are discussed for each of the stages. The data analyses are discussed thereafter.

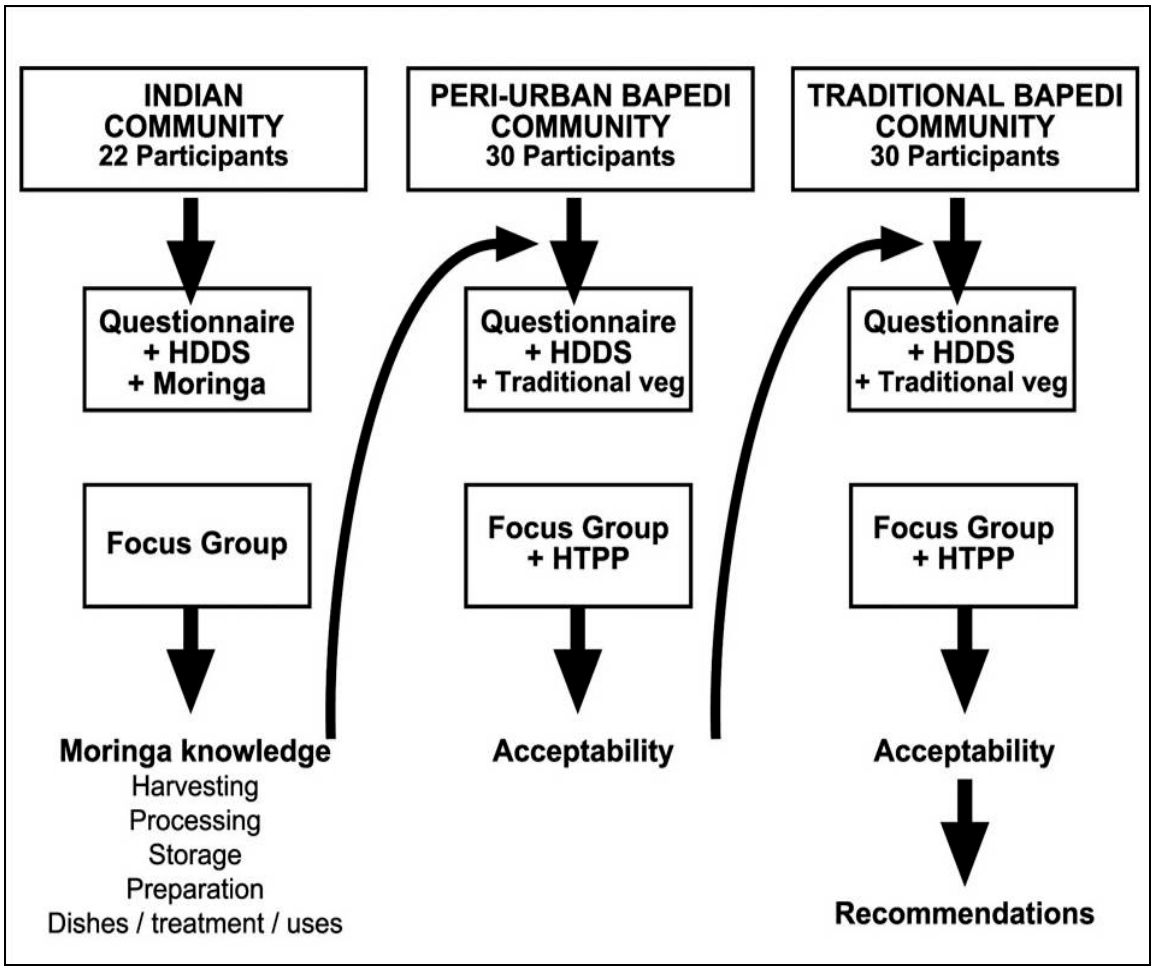

Figure 3.2: Three phases of the multi-stage research process (interview schedule refers to the semi-structured interview schedule)

Phase (i): The first phase comprised of gathering data from the Indian community on their utilisation patterns of *Moringa* as a food source. The Indian community, as food managers represents a reference group with knowledge of *Moringa*. Although purposive sampling was used to select the participants within this stage based on the presence of *Moringa* trees and the assumption that they would utilize it, it was found during the piloting visit that cultural difficulties exist in gaining access to the initial 30 participants that was decided on. It was then decided to adopt the principles of purposive

sampling based on the need to gather relatively unknown phenomenon (Strydom and Venter, 2002) such as the indigenous knowledge associated with *Moringa* utilisation patterns. For this reason the sample was declared saturated after data was gathered from 22 participants. After the fifteenth household had been interviewed, it was realised that no new information was being generated because the same answers were being given. Data gathering using the interview schedule (Appendix B) were stopped after the twenty-second household, as the information was then found to be saturated.

Data collection was done through an interview schedule to gather information on the utilisation of *Moringa* in accordance with research objective 1 namely to establish the usage patterns of *Moringa* in diets, reasons for usage and associated indigenous knowledge. This data was verified and compared to research carried out in the rest of Africa and in other parts of the world on the use of *Moringa* as discussed in chapter 2. The HDDS was determined for the Indian sample as a proxy for dietary quality. A focus group was used within this sample to triangulate and validate the knowledge and usage patterns gathered through the interview schedule. The focus group in this case comprised of five participants. All participants from the interview schedule that indicated that they were willing to be involved in the focus group were included. Discussions were initiated to gather data that could validate, triangulate and clarify the data gathered during the interview. The open-ended probing questions used during the focus group discussions for the Indians are shown in Appendix F.

Phase (ii): The second phase of the research process involved the gathering of data from the peri-urban community to address half of the objectives 2, 3 and 4 as discussed in paragraph 1.4. It is generally accepted that indigenous knowledge erodes with urbanisation and the associated westernisation and an investigation was necessary to determine if knowledge on *Moringa* existed in members of the social groups potentially introduced in the urban setting, what their usage patterns of traditional green leafy vegetables are as well as whether remarkable variations exists in the dietary diversity as compared to a traditional Bapedi community. A sample size of 30 participants was used for to conduct the interviews. The peri-urban community leader assisted in identifying different social and training organisation as access points to leaders or active members that could be interviewed. The social and training organisations that were represented were Fundisizwe Health and Social Development Services. Red-Cross, Muumpsaap and National Council Association for Women (all non-Governmental organisations) as well as educators from surrounding schools. Leaders and active members were selected due to their social position in society where the introduction of new knowledge (*Moringa*) and erosion of indigenous knowledge (traditional leafy vegetables) could provide a cross-over culture from one knowledge base to another that could accommodate acceptance of knowledge

and associated practices. The sampling type was therefore once again purposive based on the reasoning provided above.

Once again the semi structured interview schedule was administered to gather data on the utilization patterns of *Moringa* and traditional leafy vegetables as well as to determine dietary diversity, using HDDS. Due to the HDDS being a proxy for dietary quality and an indication for food security status, the need for diet diversification for the peri-urban and traditional sample could be identified.

The focus group in the peri-urban community had a dual purpose. It was firstly used to validate and triangulate the knowledge and usage data gathered in the interview schedule. The second purpose of the focus group was to test the food acceptability of dishes prepared from *Moringa* leaves using the Hedonic Test of Personal Preference (HTPP) (Den Hartog *et al.,* 2006) (Appendix C). These dishes were prepared by a participant from the Indian sample that was willing to contribute to this part of the study. The participants scored their preferences of the dishes on a form provided in Appendix C. The focus group consisted of 10 participants who indicated willingness after the interview schedule to continue participation in the study.

Phase (iii): The traditional Bapedi community formed the third stage of the research process. Due to the literature informing of results of a SAVACG in 1994 of VAD in children between six months and six years of age in South Africa indicated that Limpopo was the province with the highest rate of VAD in that group of children (Labadarios *et al* 1995) and the NFCS in 1999 of children 1-9 years of age in South Africa (Labadarios, 2000), the selection criteria for inclusion into this sample was women caring for children younger than ten years of age from the selected traditional communities. A group of 30 Bapedi women caring for children younger than ten years of age were selected as members of the social organisations of the peri-urban social leaders and confirmed for access by the senior traditional women. The interviews will be held at the facilities of two social organisations and a house next to the clinic point for members of groups selected from the three more remote villages with the help of the social leaders. The sample was selected as representative as possible of the social organizations and the five villages in the study area. Women from the traditional Bapedi communities interviewed and a focus group consisting of ten respondents was selected from the total number of participants.

The interview schedule was employed in this sample to address the remaining half of research objectives 2 and 3 (paragraph 1.4). The assumption was made that the indigenous knowledge on the traditional leafy vegetable would be less eroded in this sample and the possibility of the traditional Bapedi community acquiring knowledge on a plant such as Moringa would still be fairly limited. The focus group discussion was once again for validation and triangulation of the information gathered in

the interview schedule consisting of ten participants. The focus group furthermore evaluated various dishes that were prepared by them using Bapedi methods of cooking the dishes from the leaves of *Moringa* (Babu, 2000). The 10 members of the focus group were divided into four groups (Groups 1 and 2 had four members each, and Groups 3 and 4 had three members each). Each group was asked to use *Moringa* leaves to prepare a dish in the same manner in which indigenous green leafy vegetable were prepared in their various homes. The groups acted as an untrained community panel to record their preference as used by Babu (2000) see Paragraph 2.4. The four dishes that were prepared were lined up on a table and labelled 1 to 4. Each of the members of the focus group was requested to taste the four dishes prepared and to record their acceptability rate. HTPP score sheets were handed to the participants to rate the taste, odour, mouth feel and the appearance of the dishes that were prepared. Each of these characteristics were explained and translated into sePedi by the interviewers. The recipes used during the tasting appear in Appendix D and were developed using *Moringa* as a substitute for indigenous green leafy vegetables.

3.3.2 Data analyses

Due to the mixed methods approach employed in this study both qualitative and quantitative data analysis took place. The interview schedule comprised two parts. One part gathered data with questions on socio-demographics, knowledge on *Moringa* and traditional leafy vegetables as well as utilisation patterns and reasons for usage. The analyses of the questions included basic numerical analysis of frequencies using MS Excel, as well as qualitative descriptive data analysis on open-ended questions specifically. The second part of the interview schedule involved the dietary diversity score of households as a proxy for dietary quality and therefore the food security status of all the selected groups of women by using the HDDS. This format was adapted from the FANTA (2006) project of the United States Agency for International Development (USAID) and modified to suit the community in which data was collected. The FANTA (2006) format of measuring a household's dietary diversity is a tested and reliable instrument as a means of determining the access to the food of a household. The guidelines for scoring as designed by FANTA (2006) were used to analyse the HDDS. The field research was planned before the revised version of the guidelines was released with more refined descriptions.

The focus groups were guided by a list of open-ended probing questions (see Appendix F). Transcription of the focus groups was done and it was analysed by identifying themes that correspond to the data in the interview schedule. Like data allowed for validation and triangulation, contradicting data, if any, was qualitatively described as such in the results discussions.

A numerical analysis was done for the HTPP test according to the guidelines as provided by Den Hartog *et al* (2006). The results of the community taste panel are therefore quantified but also descriptively described. The assumption made that the HTPP (Brown, 2000) test scores could be used to judge the acceptability of *Moringa* leaves and therefore provide an indication of the possibility of including *Moringa* as a potential food source to diversify their daily diets should be used as an indicator only as further investigations and introductory programmes are required to provide a conclusive result in this regard.

3.4 Ethical considerations

Contact was made through, and permission was granted via local and tribal authorities. A letter of introduction was written and signed by the supervisor of this study for the benefit of the participants. Included in the letter was an explanation of the kind of research that was being conducted and why it was necessary to conduct this research. Secondly, individual consent form was also drafted for the participants to first read and sign, giving their consent to take part in the study (Appendix A). Furthermore participants were assured of the confidentiality of their taking part in the study. The form informed the participants that they were not under any obligation to answer any or all of the questions if they did not wish to do so and that, should they have any questions on the authenticity of the study, they could contact the supervisors of the study for confirmation. Finally, community members were assured that at the end of the study the researcher would return to the community to give a full report to them. All participants therefore participated willingly. Lastly the participatory approach throughout the research assisted in cooperation in the Bapedi communities.

3.5 Constraints

Most of the constraints faced during the study were in the Indian community which is predominantly a Muslim community. None of the women who participated in the study gave their permission to be photographed or video-taped which is recommended for indigenous research by Kuhnlein (2003). The women explained that this was against their culture. The women could also not go to the Bapedi community, since most of them needed permission from their husbands which would have extended the completion of the research unnecessarily. It was also realised that these women practised strict family values and procedures. This affected the study insofar as between one and two o'clock in the afternoon, which was usually lunch time for the family, the women would ask the researcher to be excused to prepare and serve lunch for the family.

The language barrier as a possible constraint in the traditional Bapedi community was addressed in the research plan. Most of the respondents in the traditional community could not communicate in English and for this reason; the researcher trained two Bapedi-speaking interviewers, with previous research experience, to help during the interviews. Questions were translated into sePedi and the data was in turn translated into English. This delayed the interview process, however strict control was maintained throughout to ensure verbatim translation and interpretation. For validity and triangulation two interpreters were trained.

3.6 Summary

In this chapter, the study area and population have been discussed, as well as the procedures for administering the research interview schedule. The research design, the initial visit and observation that was undertaken and data collection have also been highlighted. Ethical considerations taken into account during the study have been pointed out and finally the constraints that the researcher was faced with have been indicated. This chapter therefore provides the report on the procedures that took place to identify and document the utilisation and harvesting, processing and preservation practices of *Moringa* from an Indian community and indigenous leafy vegetables from two Bapedi communities. The chapter furthermore reports on the procedures undertaken to determine the HDDS of the various samples as well as the potential acceptability of introducing *Moringa* to the two Bapedi communities.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

The analysis of the findings discussed in this chapter will take lead from the objectives that have been set in paragraph 1.4. The socio-demographic data is provided to give background information of the samples that were drawn. The usage patterns of *Moringa* in the diet, reasons for use and associated indigenous knowledge are presented in response to research objective one. This is followed by an assessment of the variations in terms of household diet diversification for each of the samples in a response to objective two. Research objective three addresses an assessment of usage patterns of traditional leafy vegetables as consumed in Bapedi households. The acceptability of a possible introduction of Moringa as an additional traditional leafy vegetable are finally discussed in addressing research objective four.

4.2 Socio-demographic data

Socio-demographic data is provided to furnish background information of the sample groups. Due to the descriptive qualitative discussion that the result section follows, statistical quantification of data was limited to address the research objectives only and although correlations between socio-demographic data might exist, it was not pursued due to the scope that has been set by the aims and objectives of the research. Potential correlations could be investigated further in a separate study.

4.2.1 Demographic details

The number of participants interviewed in total in the Indian and Bapedi communities was 82, consisting of 22 participants from the Indian community, 30 participants from the peri-urban Bapedi community and 30 participants from the traditional Bapedi community. All the participants were female, since females are the ones mostly involved in the procurement of ingredients and the preparation of meals.

The age of the participants ranged from 17 to older than 56 years. This age range was grouped into five main categories: 17-25, 26-35, 36-45, 46-55 and 56 and above. Figure 4.1 provides a graphical representation of the various age groups of the participants. Within the Indian community the two age

groups with the highest number of participants were aged 44 to 55 years and 56 and above, consisting of 22.7% and 36.4% of the total sample respectively. These two age groups represented the largest portion of the Indian community interviewed, since it was assumed that indigenous knowledge of a plant, such as *Moringa,* would best be gleaned from older members of the Indian community. Older individuals are usually the custodians of indigenous knowledge from where it is transferred to younger generations of a community.

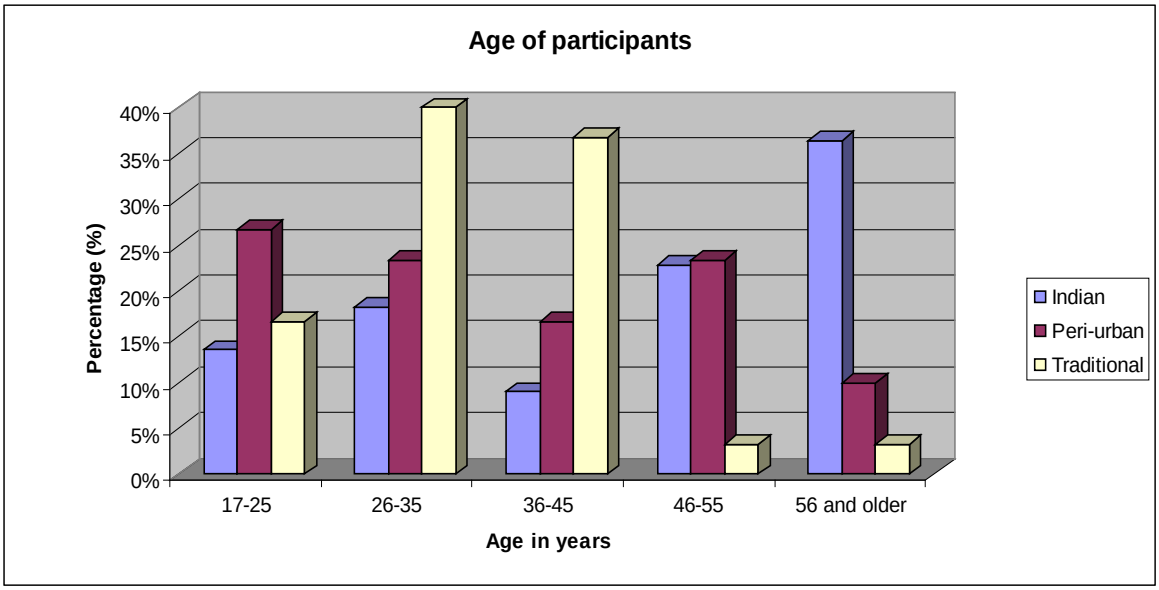

Figure 4.1: Graphical representation of the various age groups of participants

Unlike the Indian community, the peri-urban Bapedi community had the highest number of people interviewed coming from the age groups 17–25 (26.7%), 26-35 (23.3%) and 46–55 (23.3%), giving a fairly even spread throughout the various age groups for those involved in social organisations. The age groups in the traditional Bapedi community with the highest number of participants were the age group 26–35 (40%) and 36–45 (36.7 %.) The large portion of younger individuals being interviewed in the traditional Bapedi community reflects the age groups of young mothers in the rural areas. The elderly women who acted as the advisory group (senior women) of the tribal chief in the traditional community has been the custodians of the Bapedi culture on traditional food (see Paragraph 3.3). Strong notions of modernisation in their own lifestyle, modern housing and equipment were observed. The young age of the mothers was a concern, but is explained by Everatt and Smith (2008) as a tendency in rural communities to have more female headed households and refer to the feminization of rural areas. The authors also refer to ‘granny headed households’ and ‘orphan headed households’ becoming more prominent. This can explain the number of older women 56 and above with children

under the age of ten and the group 17-28 years of age. The young also have a notion towards modernisation is significant, since change has been found to be most effective amongst younger individuals. This group could more likely accept innovation and change, in contrast to individuals who are older and perceived to be more set in their ways.

4.2.2 Marital Status

Participants were categorised into five categories to determine their marital status**.** These five categories are: married, single, single but staying with a partner, divorced and widowed. Figure 4.2 is a graphical presentation of the marital status of the participants. The percentage of married participants interviewed in the Indian community was 81.1%, with 9.1% of the participants unmarried and a further 9.1% widowed. None of the participants in the Indian community was single, but staying with a partner or divorced.

Participants who were single represented 36.7% of the sample in the peri-urban Bapedi community and those who were staying with partners amounted to 23.3%. This was followed by participants who were married at 26.7% and those who were divorced at 13.3%.

Most of the participants interviewed in the traditional community (66.7%) were single mothers. The married participants in the traditional Bapedi community represented 26.7%. Those who were single and staying with a partner represented 3.3%. Divorced participants also represented 3.3% of the sample. None of the participants was widowed.

This indicate that the high percentage women of a young age with children under ten years of age are single mothers. A further notion is that the social grants as cash in the hand are used by 65% of women with children in rural areas (Everatt and Smith, 2008).

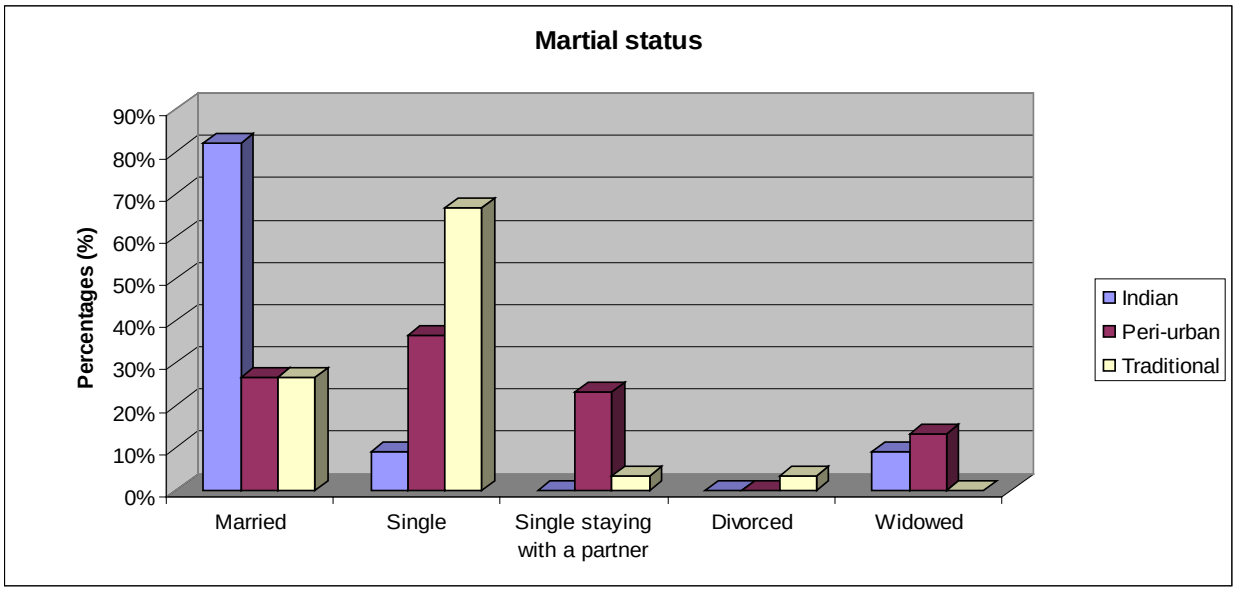

Figure 4.2: Graphical representation of the marital status of participants

The tendency of mothers to be single in the traditional Bapedi community is significant in that the traditional community is seen as the safety net in African culture for urbanised Africans maintaining family ties with the rural areas for the purpose of livelihood security and receiving cash from grants (Everett and Smith 2008).

4.2.3 Educational level

The educational level of the participants in the Indian and Bapedi communities is indicated in Figure 4.3. The highest number of participants interviewed had education up to secondary level at 59.1% in the Indian community, 36.7% in the peri-urban community and 90.1% in the traditional Bapedi communities. Participants with education up to tertiary level were 18.2% in the Indian community and 43.3% in the peri-urban community. Participants with junior primary in the Indian community represented 9.1% of the sample and 10% of the sample in the peri-urban community. Participants that could read and write represented 3.3% of the sample in both the Bapedi peri-urban community and the traditional Bapedi community.

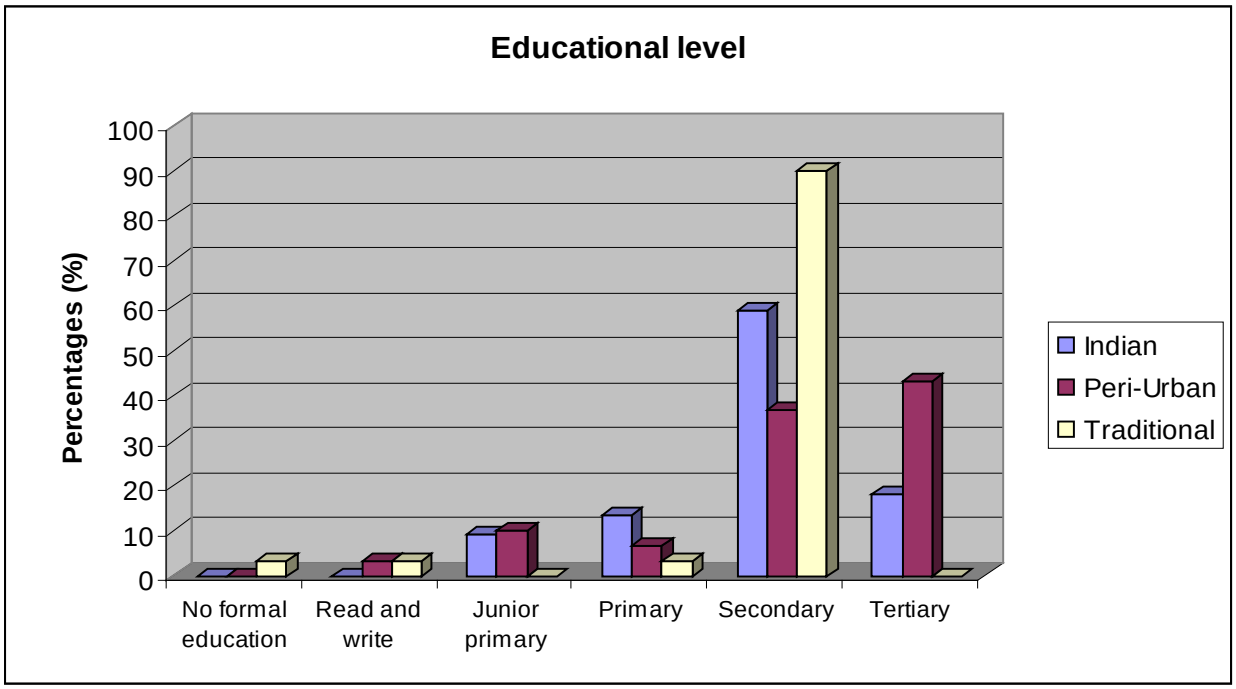

Figure 4.3: Educational level of participants

Limpopo Province is also known for its high percentage of out of school youth with secondary education who have potential for promoting food security and dietary quality. The educational level of the peri-urban group on the secondary and tertiary level has a significant impact on this study, due to its comparison with the diffusion of innovation theory that states that innovators are generally well educated (Rogers, 2003). In rural nodal areas, 22 most poor areas in South Africa, of which Sekhukhune is close to Mokopane, the average education level is 50% secondary schooling and in the urban counter parts 73%. Only 15% had no schooling and the illiteracy rate in rural nodal areas is 33% in 2008 (Everatt and Smith, 2008).

4.2.4 Employment

The employment details of all the participants are as follows: 9% of the participants in the Indian community were employed and 91% were not employed. In the peri-urban Bapedi community, 53.3% were employed and 46.7% were not employed. Sixty percent of the participants from the traditional Bapedi communities were employed as part-time workers and 40% of the participants were not employed. The socio-economic position of the young mothers is an important factor with regard to dietary quality (see Paragraph 2.8). The education and employment levels of the participants are

significant in this study due to its comparison with the diffusion of innovation theory (see Paragraph 1.3.3).

4.3 *Moringa* use investigated

As shown in chapter two literature abounds on *Moringa* use internationally and in several countries in Africa. The usage patterns and associated indigenous knowledge of *Moringa* is largely absent in South Africa. This section is intended to document *Moringa* usage patterns, reasons for use and associated knowledge within a sample of South African group that utilize *Moringa* as a food source.

4.3.1 Usage patterns of *Moringa*

It was determined in respect of the Indian community that, 22.7% of the women interviewed had grown up in India and 68.2% of the respondents had grown up in South Africa. The remaining 9.1% of the respondents had grown up in countries such as Kenya and Mozambique. The differences in the use of *Moringa* of these demographic groups were that those who grew up in South Africa consumed only the pods of *Moringa* and those who grew up in India consumed the leaves and the pods. This information came to the researcher's attention during the focus group discussions and was confirmed when the data on the place of birth was compared to the parts consumed from the interview schedule.

All the participants in the Indian community belonged to a religious group that restricted them from consuming some food items. All the participants (100%) were forbidden to consume pork, 13.6% to consume beef and 9% to consume gelatin. The recipes are therefore similar to traditional African diets in which meat is largely absent and where households depend on vegetable and starchy food source for their micro-nutrients requirement (Jansen van Rensburg *et al.,* 2007).

All the participants interviewed (100%) consumed one or more parts of the *Moringa* plant. All the interviewed participants (100%) consumed the pods of *Moringa,* 50% of the participants consumed both the leaves and the pods and 13.6% of the participants consumed the pods, leaves and the flowers. None of the participants consumed the roots or any other part of the *Moringa* plant. Therefore a total of 63.6% of the participants consumed the leaves of *Moringa.* For this reason the leaves were substituted for other leaves in the indigenous Bapedi dishes since their traditional dishes mostly make use of other leafy vegetables

4.3.2 Reasons for consuming *Moringa*

The reasons for consuming *Moringa* were grouped into three categories. Category one was *Moringa* being nutritious and healthy; category two was because it was tasty and category three was because *Moringa* was readily available. Participants had the opportunity to indicate all the reasons why they prefer to eat *Moringa* and therefore more than one option could be selected. Sixty three percent of the respondents indicated that they consumed *Moringa* because it was nutritious and healthy; 86.3% of the respondents indicated that they consumed *Moringa* because it was tasty and 13.6% consumed *Moringa* because it was readily available. Of the total sample of the Indian community, 77.2% of the respondents had no other reason for consuming *Moringa* apart from the reasons categorised above and 22.7% gave other reasons why they consumed *Moringa*. Among the reasons given for the open-ended questions during the focus group discussion were: one participant indicated that it was good for people suffering from diabetes, another participant indicated that it was likeable, and one participant indicated that she consumed *Moringa* because her mother taught her to use it. Lastly, *Moringa* was indicated by yet another participant as being good for vegetarians. Confirmation of these finding were received during the focus group discussions.

4.3.3 Associated indigenous knowledge of *Moringa*

The literature has established that *Moringa* leaves and pods are available throughout the year in certain parts of Africa and in India (Fuglie, 2001). However this study has revealed that although *Moringa* leaves are available throughout the year in South Africa, the pods and flowers are not always available for twelve months of the year. The majority of the participants (86.3%) agreed that the pods and flowers of *Moringa* are scarce during the months of May to October and all the participants indicated that *Moringa* leaves are available throughout the year. Further botanical research would be required to determine the growth patterns of *Moringa* in South Africa in specific agro-ecological localities to determine its geographical distribution and availability.

The majority of the participants (81.8%) prepared *Moringa* pods with other vegetables and 13.6% prepared *Moringa* leaves with other vegetables as well. There were 27.2% of the participants who added chicken to their *Moringa* dishes containing pods, whilst 4.5% of the participants added chicken to *Moringa* dishes containing leaves. Participants who prepared *Moringa* pods with red meat were 13.6% and 9% prepared *Moringa* leaves with red meat. Some of the participants (18%) cooked *Moringa* pods plain, whilst 4.55% of the participants prepared *Moringa* pods with either sour milk or yoghurt. The notion of using *Moringa* in mixed dishes is evident and fits in well with the cultural

practices of the Bapedi, since they also indicated that they used mixed dishes when cooking with traditional leafy vegetables.

This study revealed that none of the *Moringa* consumers in the Indian community used drying as a means of preserving *Moringa* leaves. However 31.8% of the participants used freezing to preserve *Moringa* leaves and 72.7% washed, peeled, cut and froze the pods to be used when they were not available at certain times of the year. Finally, 13.6% of the participants washed, peeled, cut and parboiled the pods before freezing them. According to Fuglie (2001), *Moringa* leaves could be picked, washed and dried in the shade, since the drying of *Moringa* in the shade prevents the loss of vitamin A. The dried leaves could then be crushed and run through a sieve to process them into fine granules. These *Moringa* granules could then be stored for up to a year in airtight containers and used as and when required (Fuglie, 2001). The focus group discussions later confirmed that preservation of *Moringa* was not done by drying but mainly by freezing.

As stated earlier in Paragraph 2.7, *Moringa* has other uses, apart from the plant being used as a food source. When asked if the respondents knew of other uses of *Moringa,* apart from it being used as a food source, 36.3% of the participants indicated Yes and 63.6% indicated that they did not know of any other uses of *Moringa*. Other uses of *Moringa* that the participants knew about that were revealed during the focus group discussions were mostly medicinal, which included the treatment of arthritis, the cleansing of the womb and stomach, and its use also for water retention. None of the respondents indicated an awareness of the uses of *Moringa* obtained in the literature review such as green fertiliser, fodder for small ruminants, seed oil or water purification even when prompted during the focus group discussions.

All the participants interviewed (100%) indicated their willingness to recommend *Moringa* as a food source to other people. During the focus group discussions, five reasons were indicated by the respondents as to why they would recommend *Moringa* to others. Forty-five percent of them indicated that they would recommend *Moringa* because it is tasty, 20% would recommend it on the basis of its being nutritious, 25% would recommend it for medicinal reasons, and 10% would recommend it because it is readily available.

The information gathered from the interview schedule on *Moringa* administered to the Indian population provided sufficient findings to support the objective that was set for this portion of the research, namely to establish *Moringa* usage patterns, reasons for use and gather associated indigenous knowledge.

4.4 Variations in dietary diversification

The use of the HDDS was indicated in paragraph 3.3.2 as a tested method to determine diet quality and therefore food security status of a household. Although it is generally accepted that a quantitative measurement such as HDDS requires large samples, it is used in this study as an indicator of potential resource poor household that would be in need of diversifying their diets. Because HDDS is used in an exploratory fashion, research needs to be followed up on a national scale to establish actual needs for dietary diversification and a holistic programme for *Moringa* acceptability would be required. On a level of indication the results on the HDDS is reported.

Every participant in the Indian community, as well as in the Bapedi communities, was requested to complete a interview schedule for HDDS. This interview schedule was administered to determine how diverse the diet of a household is. The HDDS was also intended to determine whether *Moringa* was being consumed in the Indian community and, in the case of the Bapedi communities, if *Moringa* could be added to their diets to improve the dietary quality of the households. As discussed in Paragraph 2.8, the score of the HDDS gives an indication of whether the macronutrient and micronutrient needs of a household are being supplied. The higher the score, the more diverse a household diet is said to be.

Figure 4.4 provides a graphical representation of the combined Indian, peri-urban and traditional communities' score. The HDDS results of the Indian participants were as follows: 4.5 % of the participants had a score of four; 13.3% had a score of five; 31.8% had a score of six; 22.7% had a score of seven; 18.2% had a score of eight and 4.5% had a score of nine. The average dietary diversity score of all the Indian participants was 6.2 out of a total of 12.

The peri-urban Bapedi community had an average HDDS of 6.6 out of a total of 12. Ten percent of the participants had a score of nine, 23.3% had a score of eight, and 26.7% had a score of seven and a score of five and six included 16.7% of the participants respectively. The lowest score was two with a reading of 6.7%.

The HDDS results of the traditional Bapedi community indicated that 3.3% of the participants had a score of two; 26.7% had a score of three; 30% had a score of four; 10% had a score of five and six respectively; and 6.7% had a score of seven. The average dietary diversity score of the traditional Bapedi respondents was 4.7 out of a total of 12. The mean adequacy ratio dietary diversity cut-off point for South Africa published by Steyn, *et al*. This average is lower than that of the Indian

community and also lower than half of the average score of HDDS. *Moringa* could therefore be introduced to the Bapedi community as an additional traditional leafy vegetable to enhance their micronutrient intake, especially of vitamin A.

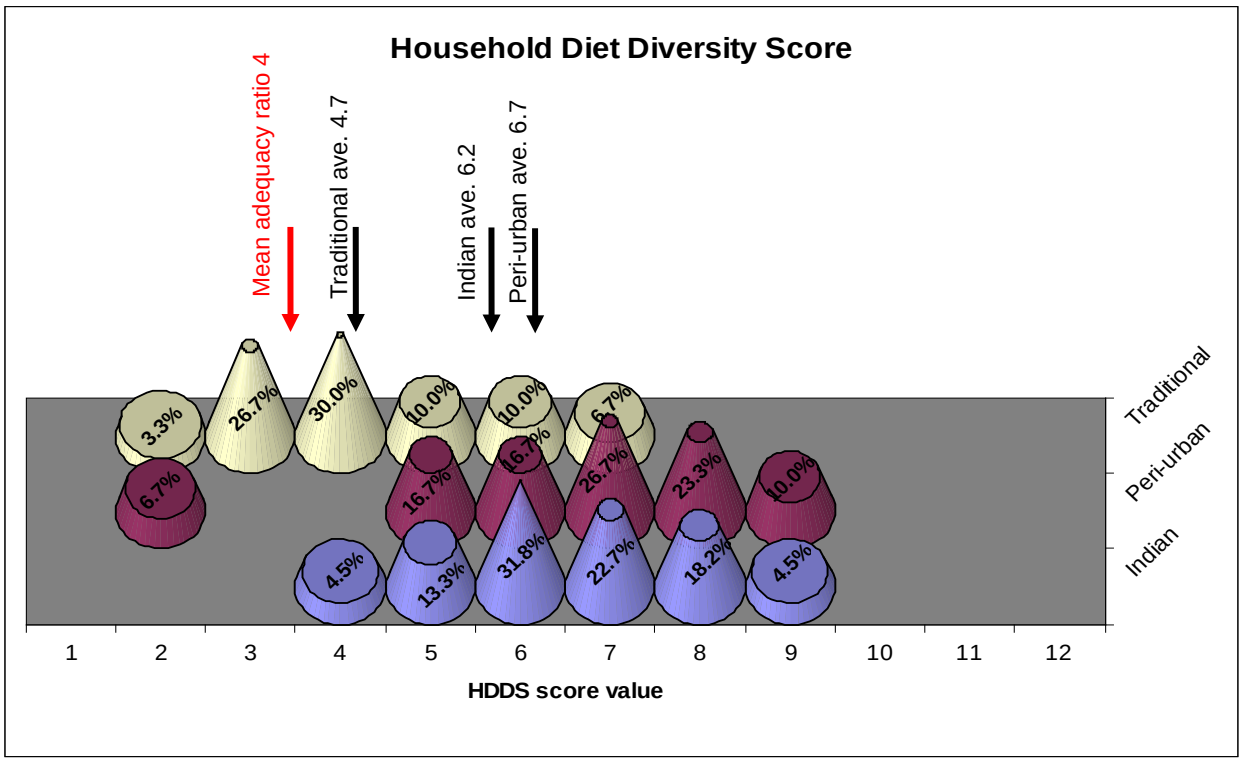

Figure 4.4: A representation of the Indian, peri-urban and traditional communities' scores.

These findings shed light on the reason why the peri-urban and traditional Bapedi groups would potentially accept *Moringa.* The HDDS was administered for this reason as discussed in Paragraph 2.8 where the assumption was made that low scores meant low diversity in diets. The findings therefore indicate variations in diet diversity and series as an indicator of potential introduction to diversify their diets. Further research would be required to confirm the indicators found in this study on a larger scale and across more cultural groups. In Paragraph 4.6 the acceptability has been discussed and it also became apparent during the focus group discussions that the peri-urban community based their acceptance of *Moringa* on its medicinal value whilst the traditional community focused on the nutritional value. This acceptance is evident from the high average peri-urban and low average traditional Bapedi scores.

4.5 Usage patterns of traditional leafy vegetables amongst Bapedi households

As part of the exploratory nature of the research, it was necessary to determine current leafy vegetable usage amongst the sample to which *Moringa* leaves were being introduced.

4.5.1 Research sample

For the peri-urban sample, community leaders were selected as potential agents of change and knowledge of what is taking place within the community. In the traditional Bapedi community, mothers of children younger than ten years of age were interviewed. They were requested to indicate the total number of people in their households, as well as the number of children younger than ten years who are in their care. The total number of children in the care of the respondents was 68 with 61.7% of them being five years and younger. The remaining 38.1% of the children were between the ages of six and nine. As discussed in Paragraph 1.2.2.1, the literature has revealed that Limpopo Province has the highest rate of vitamin A deficiency in children younger than five years of age and this was the reason why mothers of children younger than ten years of age were selected for this study.

In the peri-urban Bapedi community, the majority of the participants interviewed (93%) had cultural affiliation with the Pedi culture and 6.7% were affiliated to the Ndebele culture. The traditional Bapedi community had the same results as the peri-urban community with regard to their cultural affiliation. Ninety-three percent of them had cultural affiliation with the Pedi culture and 6.7% were affiliated to the Ndebele culture. When asked if the participants consume the *Moringa* plant, all of the peri-urban and traditional communities (100%) indicated that they did not consume *Moringa*, and also did not know the *Moringa* plant; nor were they able to identify it, although it grows abundantly in the surrounding suburbs of Mokopane.

4.5.2 Usage patterns of traditional leafy vegetables

Traditional vegetables form part of the diets of most of the participants. The participants were asked to list any five indigenous leafy vegetables that are commonly consumed by their various households. The participants in the peri-urban Bapedi community identified a total of eight traditional leafy vegetables and participants from the traditional Bapedi identified a total of 12 traditional leafy vegetables. Table 4.2 indicates a summary of identified traditional leafy vegetables consumed by both peri-urban and traditional Bapedi communities.

Table 4.1: Traditional leafy vegetables commonly consumed (peri-urban and traditional communities)

Name of indigenous vegetable in Northern Sotho (Bapedi)*	Percentage: peri-urban participants (%)	Peri-urban Rating	Percentage: traditional participants (%)	Traditional Rating
Lerotho	90	1	93.3	1
Monawa	86.7	2	46.7	4
Mophotse	80	3	26.7	6
Theepe	73.3	4	86.7	2
Thelele	43.3	5	50	3
Motshatsha	36.7	6	10	9
Monyaku	20	7	36.7	5
Phara	13.3	8	6.7	10
Lehlanye	-	-	20	7
Tshehlo	-	-	16.7	8
Duasese	-	-	3.3	11
Mokhusa	-	-	3.3	12

*Botanical names are given in Table 4.2A and 4.2B

The vegetables are rated from the most widely consumed to the least consumed, with one being the most popular and 8 to 12 being the least popular. Corresponding percentages are also given.

The parts of plants that are usually consumed were categorised into five groups. These groups are: leaves, pods, flowers, roots, and other. All the participants in the peri-urban and traditional communities (100%) consumed the leaves of the traditional plants they listed. Of the participants in the peri-urban community, 20% consumed pods, and 16.6% consumed flowers. The percentage of participants in the traditional communities who consumed pods was 23.3% whilst 16.7% consumed the flowers. None of the participants in all the communities indicated consuming any other part of the plants apart from the leaves, pods and flowers. This finding is significant due to the fact that if the participants are in the practice of consuming various parts of indigenous vegetable other than only leaves, they would more readily accept the use of various parts of a newly introduced vegetable into their diet. However, due to the entire sample consuming traditional leafy vegetables, it was appropriate to substitute *Moringa* leaves in the typical traditional recipes used for the preference testing.

4.5.3 Reasons for consuming traditional leafy vegetables

Each one of the participants in the peri-urban and traditional communities had a reason for consuming the various plants that were listed by them. The reasons that were selected as to why the various plants were consumed were, the plants being healthy and nutritious, the plants being used because they were tasty and lastly because these traditional plants were readily available. Tables 4.2A and 4.2B list the traditional plant names in isiPedi and Botanical names as indicated by the participants (peri-urban and traditional respectively) together with the various reasons given for consuming the plants.

Table 4.2A: Reasons given for consuming traditional leafy plants (peri-urban community)

Name of plant in isiPedi	Botanical name of most commonly consumed species or plants**	Reason 1 Nutritious and healthy (%)	Reason 2 Tasty (%)	Reason 3 Readily available (%)
Lerotho	*Cleome Gynandra* L. (Spider flower)	70	46.7	40
Monawa	*Vigna spp* *Vigna Inguiculata* (Cowpeas)	50	36.7	36.7
Mophotse	*Cucurbitaceae spp* *Cucurbita pepo, C, maxima* and *C. moschata* (Pumpkin and squash varieties)	53.3	40	36.7
Theepe	*Amaranthus spp* (Amarnath)	30	26.7	20
Thelele	*Corchorus olitorius* and *C. tridens* (Jews mallow)	20	20	16.7
Motshatsha	*Citrullus lanatus* (Thunb.) (Bitter water melon) *Cucumus melo* (Melon)	23.3	20	16.7
Monyaku	(Wild pumpkin varieties)	16.7	13.3	6.7
Phara	Name not known	6.7	3.3	3.3

** **The botanical names of the plants listed in vernacular are derived from Jansen van Rensburg *et al.* (2007) and Quin (1959)**

Table 4.2B: Reasons given for consuming traditional leafy plants (traditional community)

Name of plant in isiPedi	Botanical name of most commonly consumed species**	Reason 1 Nutritious and healthy (%)	Reason 2 Tasty (%)	Reason 3 Readily available (%)
Lerotho	*Cleome Gynandra* L. (Spider flower)	56.7	73.3	50
Theepe	*Amaranthus spp* (Amaranth)	40	36.7	36.7
Thelele	*Corchorus olitorius* and *C. tridens* (Jews mallow)	26.7	36.7	30
Monawa	*Vigna spp* *Vigna Inguiculata* (Cowpeas)	26.7	23.3	20
Monyaku	(Wild pumpkin varieties)	10	6.7	3.3
Mophotse	*Cucurbitaceae spp* *Cucurbita pepo, C, maxima* and *C. moschata* (Pumpkin and squash varieties) (Pumpkin varieties)	23.3	23.3	20
Lehlanye	Name not known (Wild leaves)	10	13.3	6.7
Tshehlo	Name not known (Wild leaves)	-	20	-
Motshatsha	*Citrullus lanatus* (Thunb.) (Bitter water melon) *Cucumus melo* (Melon)	6.7	6.7	3.3
Phara	Name not known (Wild leaves)	3.3	6.7	3.3
Duasese	Name not known (Wild leaves)	-	3.3	3.3
Mokhusa	Name not known (Wild leaves)	-	3.3	-

** The botanical names of the plants listed in vernacular are derived from Jansen van Rensburg *et al.* (2007) and Quin (1959)

The above findings are integrated into a graph in Figure 4.5 to enable one to visualise the pattern. A significant finding is that traditional food is regarded as nutritious and tasty by the participants.

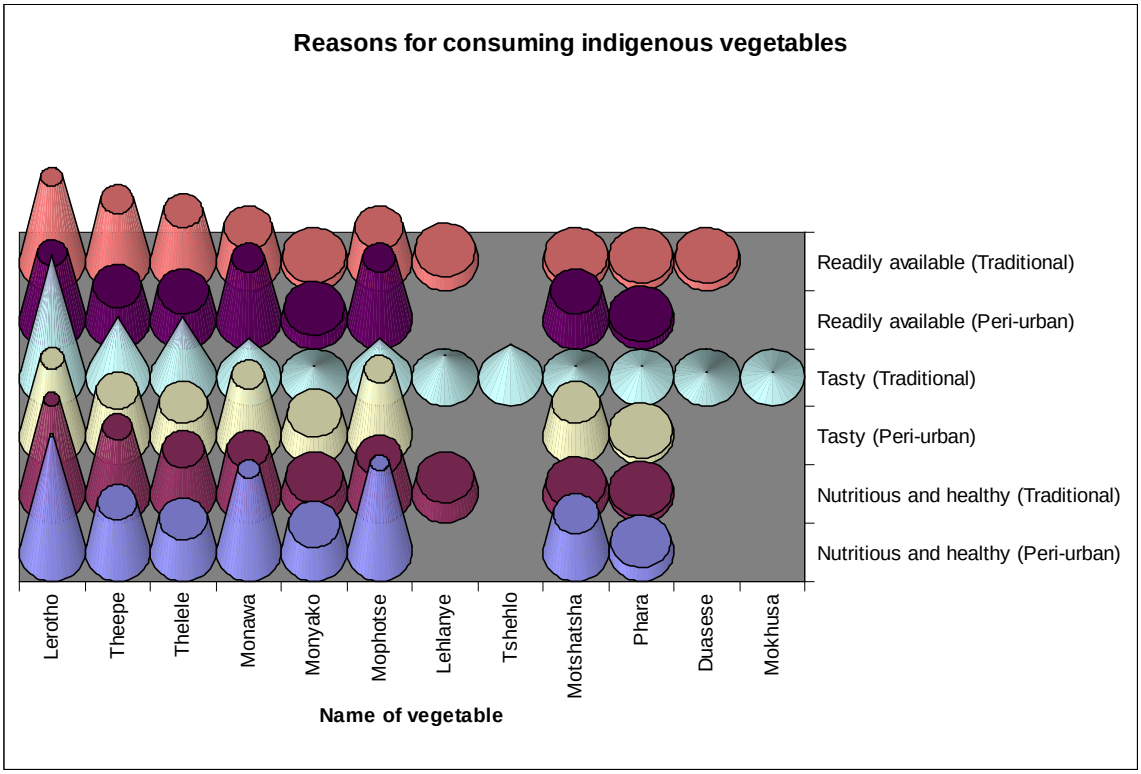

Figure 4.5: Graphical representation of reasons given for consuming traditional leafy vegetables

When asked for other reasons for consuming the traditional plants apart from the ones given, 86.7% of the participants in the peri-urban community indicated not knowing of any other reason for consuming the traditional plants and 13.3% indicated other reasons. The other reasons included the plant being medicinal, the ease with which it could be grown by themselves (20%), and that using it saves money (6.7%).

4.5.4 Associated indigenous knowledge of traditional leafy vegetables

The months that were indicated by the participants as times when the traditional plants are scarce were given, based on seasonal changes. All the participants indicated that the traditional plants were scarce during winter months. Table 4.3 lists the various seasons in which traditional plants are scarce, as indicated by participants in the peri-urban and traditional communities.

Table 4.3: Seasons in which traditional leafy vegetables are scarce

Season	Percentage (%) – Peri-urban Community	Percentage (%) – traditional Community
Spring	10	3.3
Summer	3.3	3.3
Autumn	6.7	16.7
Winter	80	76.7

The peri-urban people have various ways of preparing traditional leafy vegetables. When the participants were asked to describe how traditional leafy vegetables were prepared in their homes during the interview, it was stated that they would most of the time prepare the traditional leafy vegetables with other vegetables. Others also added red meat, chicken or fish. Those who added other ingredients to their traditional leafy vegetables were adding peanut butter or packet soup to the preparation of these vegetables. Phara was the only traditional leafy vegetable consumed on its own, without adding other ingredients. Table 4.4 lists the different traditional leafy vegetables, along with the percentages of participants who use red meat, chicken, fish and other vegetables in preparing their traditional vegetable dishes.

In the traditional community, it was realised that all the participants prepared the traditional vegetables with other vegetables. None of the participant prepared the traditional vegetables with red meat, chicken or fish. The few respondents (30%) who added other ingredients to their traditional vegetables were adding peanut butter or packet soup to the preparation of their vegetables. Just as in the case of the peri-urban community, only phara was consumed on its own, without adding other ingredients. By adding *Moringa*, the absence of adding protein and micro-nutrients in the form of red meat, chicken or fish could make the indigenous leafy vegetables more nutritious.

Table 4.4: Ingredients added to traditional leafy vegetable dishes. (Peri-urban and traditional communities) given as percentages

Name of plant	Meat		Chicken		Fish		Vegetables		Other ingredients	
	P%	T%	P%	T%	P%	T%	P%	T%	P%	T%
Leroto	6.7	-	3.3	-	3.3	-	93.3	73.3	13.3	10
Monawa	3.3	-	-	-	3.3	-	43.3	36.7	13.3	3.3
Mophotse	-	-	-	-	-	-	43.3	26.7	6.7	3.3
Theepe	3.3	-	3.3	-	-	-	76.7	56.7	6.7	3.3
Thelele	6.7	-	3.3	-	3.3	-	46.7	73.3	13.3	3.3
Motshatsha	-	-	-	-	-	-	36.7	-	-	-
Monyaku	3.3	-	3.3	-	-	-	20	46.7	-	6.7
Phara	-	-	-	-	-	-	-	-	-	-
Lehlanye	-	-	-	-	-	-	-	26.7	-	-
Tshetlo	-	-	-	-	-	-	-	20	-	-
Duasese	-	-	-	-	-	-	-	3.3	-	-
Mokhusa	-	-	-	-	-	-	-	3.3	-	-

P% – Percentage of vegetables used in peri-urban community

T% – Percentage of vegetables used in traditional community

When the participants in the peri-urban community were asked if they harvested, processed and preserved the traditional plants for future use, 96.7% indicated *Yes* and 3.3% indicated *No* to the question. In the traditional community, 83.3% indicated *Yes* and 16.7% stated *No* to the question. Through the focus group discussions, participants in the peri-urban and traditional communities who preserved the traditional leafy vegetables indicated that they would pick them from the field or garden and wash them. The vegetables would then be boiled and mashed into a paste. The vegetable paste was shaped into tiny balls and dried in the sun. When the vegetable balls were thoroughly dry, they were stored in airtight containers to be used when fresh traditional vegetables were scarce. However, 53.3% of the participants in the peri-urban community indicated storing traditional leafy vegetables in a freezer as a method of preservation. Masekoameng (2007) states that in the Sekhukhune district of Limpopo Province, traditional vegetables were processed by washing and cooking them. The cooked leaves were then mashed and rolled into tiny balls and dried on top of corrugated iron roofing sheets. This corroborates the responses from participants on how traditional leafy vegetables are processed and stored in the sampled Bapedi communities both during the interviews as well as during the focus group discussions. Further research would be required to analyse the loss of nutrient value in these various processing techniques.

In the peri-urban community, the majority of the participants (83.3%) did not know of any other uses of the traditional leafy vegetables apart from being used as a food source, whilst 16.7% indicated that they knew of other uses of traditional leafy vegetables. In the traditional community, 83.3% of the participants did not know of any other uses of the traditional leafy vegetables apart from their being used as a food source. However 16.7% indicated that they knew of other uses of traditional leafy vegetables. These participants indicated, in response to an open-ended question during the focus group discussions, that traditional leafy vegetables were good for controlling high blood pressure, hepatitis, heart burn and for treating the joints. The medicinal value would once again make for ideal future research, since it falls beyond the parameters of this study.

Due to information gathered in the focus group discussions it proved viable to replace traditionally used leafy vegetables with *Moringa* leaves to test the preference of the two Bapedi sample groups.

When the participants were asked if they would like to be introduced to another green leafy vegetable that could grow well in their community and could be added to their dishes as well as other uses of the plant, 100% from the peri-urban and 100% from the traditional communities indicated *Yes*. The participants were asked if they would be willing to participate in a focus group discussion and also to prepare and taste dishes with *Moringa* leaves and once again 100% said *Yes*. The random selection of the sample for the focus group therefore took place from the entire sample used in the interview schedule administration process. The focus group discussions at this point focused on the introduction of *Moringa* plant to the group. Various uses of the plant was communicated to the group by the researcher and *Moringa* plant samples were shown to the group.

4.6 Acceptability of dishes prepared with *Moringa* leaves

Research objective four was stated to determine the acceptability of dishes prepared by substituting traditional green leafy vegetables with *Moringa* leaves.

4.6.1 Peri-urban community

A total of 20 participants from the focus group were requested to taste a dish prepared with *Moringa* leaves. The HTPP forms were distributed to the participants and they were requested to give their ratings on the taste, odour, mouth feel and appearance of the dish prepared. The ratings were scored according to the guidelines set by HTPP and discussed in paragraph 3.3.2. The total score of the prepared dish was 20 and the overall score was 400, calculated by multiplying the score of 20 by 20

participants. The peri-urban participants scored a total of 391 out of 400 and a total percentage of 97.75%. The hedonic scale of the peri-urban sample indicated a total acceptability of *Moringa* leaves. This total acceptability put the peri-urban participants into the opinion leaders' category. They took on the new idea of the possibility of incorporating *Moringa* into the diet of their households and could be utilised as innovators of this change. According to Rogers (2003), "innovators are risk takers who put themselves up in front. Generally, they are well educated and have a high income to absorb a mistake". Of all the participants interviewed in the various communities, the highest number of those with tertiary education was from the peri-urban community. In that same community, more than 50% of the respondents were employed.

4.6.2 Traditional community

A total of 10 participants were selected for the focus group discussions. After the discussions, the 10 participants were divided into four groups. Group 1 had four members, Group 2 had four members, Group 3 had three members and Group 4 had three members. A total of four *Moringa* dishes were prepared by the four groups; each group preparing one dish. The respondents were asked to prepare the dishes in the same way that traditional leafy vegetables are prepared in their households, but substituting *Moringa* leaves for the regular traditional leafy vegetable. The participants were requested to taste the dishes prepared using HTPP forms that were given to them to enable them to rate the various dishes. At the time of tasting each respondent was required to do the tasting individually and to give her individual preferences on the taste, odour, mouth feel and the appearance of a particular dish, so that none of them could be influenced by the others. The dishes that were prepared were labelled Dish 1 to Dish 4. Full recipes are available in Appendix D and individual summaries of the HTPP for each dish are available in Appendix E. Table 4.5 gives the total score of the dishes, as well as the percentage of the various dishes prepared. The total score of a dish is calculated by adding together the marks for taste, odour, mouth feel and appearance. The overall score per dish could be a total of 200, calculated by multiplying a total mark of 20 per scale with 10 respondents for each dish. To calculate the total percentage of a dish, the following formula was therefore used:

$$\frac{\text{Overall score per dish} \times 100}{\text{Total score per dish}}$$

Table 4.5: Hedonic Test of Personal Preference (Dishes 1 to 4)

	Dish	Total score	Total percentage (%)
Peri-urban Community	Dish 1	391	97.75
Traditional Community	Dish 1	175	87.5
	Dish 2	107	53.5
	Dish 3	94	47
	Dish 4	200	100

Dish 1 was prepared with water, tomatoes and chillies. The dish proved to be popular with the respondents and obtained the highest score of 175, with a total acceptability percentage of 87.5%. Dish 2 received a score of 107 out of 200. It was prepared with oil, onion and tomatoes. The acceptability percentage was 53.5%. Dish 3 was also prepared with oil, and peanut butter. It was the least acceptable of all the dishes prepared, with a total score of 94 and an acceptability percentage below 50%. Dish 4 was the most popular of all the dishes. The dish was prepared with water and flavourings such as curry powder and packet soup was added. The acceptability percentage was 100%. It was observed that the dishes that were prepared with water proved to be more popular than those prepared with oil. Oil on the other hand is needed for the absorption of vitamin A (Van Wyk *et al,* 1985). The dishes are shown in the figure below.

Figure 4.6: Dishes 1-4 prepared by traditional Bapedi focus group

4.7 Summary

The results of all the communities (Indian and Bapedi) of this study have been discussed in detail in this chapter. The HDDS results have provided the support that was required to introduce a new highly nutritious food source firstly to the peri-urban community, in their potential role as agents of change, and secondly to the traditional community based on the need found in their HDDS to diversify their nutritional intake. The information on *Moringa* gathered from the Indian community provided the information that was needed to document the current utilisation patterns of a community familiar with *Moringa* which has informed the potential introduction of *Moringa* to a traditional group not familiar with *Moringa,* but in need of increasing the micro-nutrient intake in their diets.

The results of the HTPP provide sufficient evidence to determine the level of acceptability amongst the sample groups according to which they might accept an introduced food source. The acceptability of *Moringa* dishes by the peri-urban community was higher than that of the traditional community, possibly because the participants in the peri-urban community had higher educational qualifications and furthermore because most of them were also employed. This kind of situation, according to Rogers (2003), provides the opportunity to initiate change through intervention. It is suggested that, different methods of preparing dishes using *Moringa* should be tried, by the relevant informant until this individual finally finds a particular method that will best suit her family's needs and taste.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of the study was to determine the possibility of using *Moringa* leaves to improve dietary quality and diversity and also to determine the level of acceptability of the leaves of *Moringa* to be included in the diet as an additional food source to improve vitamin A intake. This chapter will discuss the summary of the findings of the study, the conclusions that the researcher came to and finally, recommendations on the study will be highlighted.

5.2 Summary of the findings

Mokopane was chosen as a study area for four main reasons. The first reason was that *Moringa trees* were found to be growing in the locality. Secondly a literature review revealed that Limpopo Province has the highest rate of vitamin A deficiency in young children younger than five years of age. Thirdly, a group of Indian residents were found to be using *Moringa* as part of their diet. Lastly a peri-urban Bapedi community and a traditional Bapedi community were found in the Mokopane area that could be assessed in terms of their need to diversify their diets.

Qualitative research was conducted to gather empirical data by making use of interview schedules and focus groups. Twenty-two Indian women were interviewed as a reference group on their traditional use of *Moringa* leaves and their preparation. Two samples consisting of 30 Bapedi women from the peri-urban community and 30 Bapedi mothers with children younger than ten years of age from the traditional community were interviewed. They were questioned as to their awareness and use of *Moringa,* as well as on the traditional vegetables commonly used in their traditional diets. The dietary diversity score of all sampled women was determined using the Household Dietary Diversity Score (HDDS) interview schedule (FANTA, 2006). Furthermore, The Bapedi women tested dishes prepared with *Moringa* leaves and evaluated the dishes using the Hedonic Test of Personal Preference (Brown, 2000). This process was carried out to determine the acceptability of *Moringa* leaves as an indication of the possibility of including *Moringa* as a potential food source.

Five main factors related to the objectives were measured during the study. These are

1) the knowledge of *Moringa* by the Indian community
2) the household dietary diversity of the Indian community
3) the household dietary diversity of both the peri-urban community and the traditional Bapedi community
4) the knowledge of other traditional green leafy vegetables known to the peri-urban and traditional community and
5) the acceptability to the Bapedi communities of dishes prepared with *Moringa* leaves.

The following are the results of the five factors that were measured:

1) The results of the knowledge of *Moringa* by the Indian community indicated that apart from *Moringa* leaves being used as a food source, the majority of the participants in the Indian community (63.3%) did not know of other uses of *Moringa* and only half (50%) of the participants consumed the leaves of *Moringa,* which is rich in micronutrients, especially vitamin A.

2) As stated earlier in Chapter 4, the household dietary diversity of the Indian community indicated an average score of 6.2 out of a total of 12. The mean adequacy ratio of four has been identified, below which nutritional inadequacy is said to exist (Steyn *et al*, 2005). The participants therefore have a diverse diet and consume *Moringa* for reasons other than it's contributing to the dietary quality of a household. The main reason given for consuming *Moringa,* as indicated by the participants (86.3%), is because *Moringa* is tasty and is not being consumed for its nutritional value.

3) The HDDS results of the peri-urban Bapedi community indicated that they had an average score of 6.6 out of a total of 12. The traditional Bapedi participants had an average score of 4.7 out of a total of 12 food groups. This is a lower average than that of the Indian and peri-urban communities. Therefore *Moringa* could be introduced to the traditional Bapedi community as an additional traditional leafy vegetable to diversify their diets.

4) It was noted that traditional leafy vegetables formed part of the daily diets of all the participants interviewed in the Bapedi communities. The participants had good knowledge of the local traditional green leafy vegetables and a total of nine traditional leafy vegetables were indicated

by the peri-urban participants as the most popular ones that were consumed by most of them. The traditional peri-urban community also indicated a total of 12 traditional vegetables as the ones generally consumed by them. Most of the participants indicated that they consume traditional plants because they consider it tasty. The participants were also keen to know about *Moringa* as an additional traditional leafy vegetable to be added to their diets.

5) The acceptability rate of the *Moringa* dishes prepared for the peri-urban Bapedi community was very high, with 97.7% of the participants indicating the taste of the dishes as very good. The odor, mouth feel and appearance of the prepared *Moringa* dishes all had high scores. The traditional community provided varying rates of preference respectively 87.5%, 53.5%, 47% and 100% for the four prepared dishes, that is Dishes 1 to 4 with an average acceptability rate of 72% (Table 4.5). The acceptability rate is therefore high enough to investigate the possible promotion of *Moringa* as an option for the alleviation of micro-nutrient deficiency, specifically with regard to vitamin A.

5.3 Conclusions

Conclusions are drawn from the specific objectives of the study as indicated in Chapter one. These objectives are as follows:

(1) To identify households that make use of *Moringa* in their diets and why they do so.
(2) To identify and assess households that require dietary diversification.
(3) To determine the acceptability of various dishes prepared from *Moringa* leaves to the identified households.

The findings of this study have indicated that all the Indians consumed the leaves and/or pods of *Moringa* and that the main reason for consuming *Moringa* was because of the taste and not because of its high micronutrient quality, as initially expected by the researcher. This study has also proved that although *Moringa* grew abundantly in the Indian community in Mokopane, neither the peri-urban community nor the traditional Bapedi community in Mokopane knew anything about the plant and none of the Bapedi participants had ever consumed *Moringa*. The HDDS in the Indian community and the peri-urban Bapedi community indicated that the participants had average dietary diversity, whereas the HDDS score in the traditional Bapedi community indicated that they had low dietary diversity. This provided the required directive that the Bapedi participants have a need to diversify their dietary intake. *Moringa* could therefore be introduced to community members as a good source of micronutrients which could be added to their diets. Although *Moringa* was a relatively new plant to the

participants of the Bapedi communities, the acceptability score of the dishes prepared provided sufficient evidence that *Moringa* could be introduced to them as an alternative food source. Finally, unlike the traditional leafy vegetables that were indicated to be scarce during certain months of the year, *Moringa* leaves are available throughout the year and could be an alternative source of green leafy vegetables at a time when other traditional leafy vegetables are scarce.

5.4 Recommendations

Although *Moringa* is a plant that has received attention in many countries, due to the high nutritional value of its leaves, little of this plant is known in South African communities. It is therefore recommended that acceptability studies amongst other cultural groupings be initiated and that *Moringa* could be considered as a source of supplementation in households' diets where the need requires micronutrient supplementation. Intervention programmes have to be designed and investigated and health workers in rural clinics and disadvantaged communities could be educated on the attributes of *Moringa* so that these health workers could in turn educate the mothers of malnourished children. This is an inexpensive and natural method of alleviating malnutrition.

Apart from being used as food, *Moringa* has other uses like its medicinal applications, water purification, seed oil and use of the green leaves as green manure which could be beneficial to disadvantages communities. However, further research is required to

1) conduct nutritional analysis of *Moringa* in South Africa as well as the traditional leafy vegetables consumed by the Bapedi (funds has already been secured)
2) investigate indigenous preservation methods in order to retain the nutritional value of preserved food for low-income households
3) establish the medicinal value of *Moringa*
4) examine *Moringa* seeds for oil production and water purification
5) test the acceptability of *Moringa* in other communities and within other cultural groupings for a wider awareness of the *Moringa* plant as a possible addition to traditional green leafy vegetables
6) investigate the implementation of a national intervention strategy that uses *Moringa* as a supplement for micronutrient deficiency and finally
7) other forms of *Moringa* products such as dried leaf powder and juice from the leaves could be developed and marketed.

REFERENCES

Aphane, J., Chanda, M.L., and Olouch, M.O. 2003. 'Increasing the Consumption of Micronutrient-rich Foods through Production and promotion on Indigenous Foods': *Proceedings of the FAO-AVRDC International Workshop*, Arusha, Tanzania, 5-8 March 2002. AVRDC Publication.

Babu, S.C. 2000. Rural Nutrition Interventions with Indigenous Plant Food – A Case Study of Vitamin A Deficiency in Malawi. *Biotechnology, Agron, Soc. Environ* 2000: 4(3)

Bennion, M. 1995. *Introductory Foods.* 10th ed. New Jersey: Prentice – Hall.

Brown, A. 2000. *Understanding Food Principles and Preparation*. USA: Wadsworth.

Coovadia, H.M. and Wittenberg, D.F. 2003. *Paediatrics and Child Health. A Manual for Health Professionals in Developing Countries.* 5th ed. Cape Town: Oxford University Press.

Creswell, J. W. 1994. Research design: qualitative and quantitative approaches. Thousand Oaks: Sage.

Den Hartog, A. P., van Staveren, W. A. and Brouwer, I. D. 2006. *Food habits and consumption in developing countries: manual for field studies*. The Netherlands: Wageningen Academic Publishers.

Everatt, D. and Smith, M.J. 2008. Building sustainable Livelihoods: The Department of Social Development's study on the ISRDP and URP. Pretoria: Department of Social Development.

Drewnowski, A., Henderson, S. A., Driscoll, A. and Rolls, B. 1997. The Dietary Variety Score: Assessing dietary quality in healthy young and older adults', *Journal of the American Dietetic Association,* 97 (3) : 266-271.

Drewnowski, A., Henderson, S. A., Levine, A., and Hann, C. 1999. Taste and food preferences as predictors of dietary practices in young women, *Public Health Nutrition*, 2(4), 513-519.

Fahey, J.W. 2005. 'Moringa oleifera: A review of the Medical Evidence for its Nutritional, Therapeutic, and Prophylactic Properties Part 1', *Trees for Life Journal*.

FANTA. 2006. *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access*: *Indicator Guide*, Washington, D.C.

FAO. 2008. *Expert Consultation on Nutrition Indicators for Biodiversity; Food composition*. Rome: Italy.

Foidl, N., Makkar, H.P.S. and Becker, K. 2001. The potential of Moringa oleifera for agricultural and industrial uses in *"THE MIRACLE TREE".* Dakar, Senegal. 45-76.

Freiberger, C.E., Vanderjagt, D.J., Pastuszyn, A., Glew, R.S., Mounkaila, G., Millson, M., Glew, R.H. 1998. 'Nutrient content of the edible leaves of seven wild plants from Niger', *Plant Foods for Human Nutrition* 53: 57-69.

Fuglie, L.J. (ed.) 2001. The Miracle Tree: The Multiple Attributes of *Moringa.* Dakar: Senegal

Ghebremicheal, K.A., Gunaratna, K.R., Henricksson, H., Brumer, H. and Dalhammar, G. 2005. 'A simple purification and activity assay of the coagulant protein from Moringa oleifera seeds', *Water Research* 39: 2338-2344.

Hart, T. And Vorster, I. 2006. *Indigenous knowledge on the South African landscape: potentials for agricultural development*. Cape Town: HSRC Press.

Hatlóy, A., Torheim, L. E. And Oshaug, A. 1998. 'Food variety – a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa', *Eur. J. Clin. Nutr. 52: 891-898.*

Herr, K. and Anderson, G.L. 2005. *The Action Research dissertation: A guide for students and faculty.* USA: Sage.

Higher Education Academy. 2002. Action Research diagrams. [Online]. Available at: htpp://www.heacademy.ac.uk/assets/hlst/documents/heinfe_exchange/acts_res_cycle.doc. (Accessed: 14/10/2008).

Jahn, S.A. 1996. 'On the introduction of a tropical multipurpose tree to China: Traditional and potential utilisation of *Moringa oleifera* LAMARK (Moringaceae)', *Senckenbergiana biologica* 75(1/2) : 243-254.

Jahn, S.A.A. 1998. 'Using Moringa seeds as coagulants in Developing Countries', *Journal Awwa Management Operations*: 43-50.

Jansen van Rensburg, W. S., van Averbeke, W., Slabbert, R., Faber, M., van Jaarsveld, P., van Heerden, I., Wenhold, F. and Oelofse, A. 2007. 'African leafy vegetables in South Africa', *Water SA* 33 (3): 317-326.

Johns, T. 2003. 'Plant biodiversity and malnutrition: simple solutions to complex problems, theoretical basis for the development and implementation of a global strategy linking plant genetic resource conservation and human nutrition', *African Journal of Food, Agriculture, Nutrition and Development* 3. (1).

Klennert, K. 2005. *Achieving Food and Nutrition Security. Actions to Meet the Global Challenge*: A Training Course Reader. Bonn: InWEnt and GTZ.

Kuhnlein, H. V. 2003. *Micronutrient nutrition and traditional food system of indigenous peoples*. Rome: FAO.

Labadarios, D., Van Middelkoop, A., Coustsoudis, A., Eggers, R. R., Hussey, G., Ijsselmuiden, C. and Kotze, J. P. 1995. *Children aged 6 to 71 months in South Africa, 1994: their anthropometric, vitamin A, iron and immunisation coverage status.* South African Vitamin A Consultative Group (SAVACG), Isando. 335.

Labadarios, D. Ed. 2000. The National Food Consumption Survey (NFCS): Children aged 1- 9 years, South Africa, 1999 Part II. South Africa: Stellenbosch.
http://www.sahealthinfo.org.za/nutrition/updatesnfcspart2.pdf. (Accessed : 27 March 2008).

Lewin, K. 1948. 'Action Research and minority problems', *Journal of Social Issues*, 2: 34-46.

Lockett, C.T., Calvert, C.C. and Grivetti, L.E. 2000. *Energy and micronutrient composition of dietaty and medicinal wild plants consumed during drought.* Study of rural Fulani, north-eastern Nigeria.

Marcu, M.G. 2005. *Miracle Tree*. La Canada: KOS Health publications.

Masekoameng, M. 2007. *Indigenous knowledge systems in food gathering and production in selected rural communities in Sekhukhune district of the Limpopo Province.* Unpublished Master's dissertation, University of Limpopo.

Masekoameng, M. R., Ferreira, F. M. and Molotja, M. C. 2003. *Food habits of the Pedi in seven villages in the Sekhukhune District, Limpopo Province.* Women in Research, NRF: DSSH.

McBurney, R. P. H., Griffin, C., Paul, A. A. and Greenberg, C. 2004. 'The nutritional composition of African wild food plants: from compilation to utilization', *Journal of Food Composition and Analysis* 17, 277-289.

Modi, M., Modi, A. T. and Hendricks, S. 2006. 'Potential role for wild vegetables in household food security: A preliminary case study in KwaZulu-Natal, South Africa', *African Journal of Food Agriculture Nutrition and Development* 6 (1).

Mouton, J. 2001. *Understanding Social Research*. Cape Town: Van Schaik Publishers.

Murro, J.K., Muhikambele, V.R.M. and Sarwatt, S.V. 2003. 'Moringa oleifera Leaf Meal Can Replace Cottonseed Cake in the Concentrate Mix Feed with Rhodes Grass (Choris gayana) Hay for Growing Sheep', *Livestock Research for Rural Development* 15 (11).

National Research Council (NRC). 2006. *Lost Crops of Africa: Volume II: Vegetables.* [Online]. Available at: http://www.nap.edu/catalog/11763.html. (Accessed: 23 July 2007)

Nambiar, V.S. 2006. 'Nutritional potential of Drumstick leaves: an Indian Perspective', Proceeding of a conference: *Moringa and other highly nutritious plant resources: Strategies, standards and markets for a better impact on nutrition in Africa,* Accra, Ghana, November 16-18, 2006.

Nambiar, V.S. and Seshadri, S. 2001. 'Bioavailability trials of beta-carotene from fresh and dehydrated drumstick leaves (Moringa oleifera) in a rat model', *Plant Foods for Human Nutrition* 56: 83-95.

Ndabigengesere, A. and Subba, N.K. 1998. 'Quality of water treated by coagulation using Moringa oleifera seeds', *Water Research* 32(3), 781-791(11).

Nesamvuni, C. N. 2000. *The Use and Nutritional Value of Common Edible Indigenous Green Leafy Vegetables in the Diet of the vhaVenda.* Unpublished Masters Thesis. University of the North.

O'Brien, R. 2001. *An overview of the Methodological Approach of Action Research*. In Roberts, R. (ed). *Theory and practice of Action Research.* [Online] http://www.web.ca/-robrien/papers/arfinal.html. (Accessed: 20 January 2002)

Okuda, T., Baes, A.U., Nishijima, W. and Okada, M. 1999. 'Improvement of extraction method of coagulation active components from Moringa oleifera seeds', *Water Research* 33 (15) : 3373-3378.

Okuda, T., Baes, A.U., Nishijima, W. and Okada, M. 2001. 'Isolation and characterization of coagulant extracted from *Moringa oleifera* seeds by salt solution', *Water Research* 35 (2) : 405-410.

Onyango, A. W. 2003. 'Dietary diversity, child nutrition and health in contemporary African communities', *Journal of Comparative Biochemistry and Physiology,* Part A 136 : [online] 61-69.

Palada, M. C., 1996. Moringa (*Moringa oleifera* Lam): a versatile tree crop with horticultural potential in the subtropical United States. Horticultural Science 31 (5), 794-797.

Price, M.L 2000. *The Moringa Tree*. USA: ECHO Publishers.

Quin, P. J. 1959*. Foods and feeding habits of the Pedi with Special Reference to Identification, Classification, Preparation and nutritive value of the Respective Foods.* Johennesburg: Witwatersrand University press.

Rajangam, J., Azahakia, M.R.S., Thangara, T., Vijayakumar, A. and Muthukrishan, N. 2001. 'Status of Production and Utilisation of Moringa in Southern India', *Workshop Proceedings*. Dar es Salam. Tanzania.

Rachmandran, C., Peter, K. V. and Gopalakrishnan, P. K. 1980. Drumstick (*Moringa oleifera*): a multipurpose Indian vegetable. Economic Botany 34 (3), 276-283.

Roberts, M. 2007. *Companion Planting*. Pretoria, South Africa: Briza Publications.

Rogers, E. 2003. *Diffusion of innovations*. 5th ed. New York: The free press.

Reason, P. and Bradbury, H. 2006. *Handbook of Action Research: The concise paperback edition.* London: Sage.

Rose, D., Meershoek, S., Ismael,C. And McEwan, M. 2002. Evaluation of a rapid field tool for assessing household diet quality in Mozambique. *Food and Nutrition Bulletin*. 23 (June): 181-189.

Ruel, M. T. 2003. 'Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs', FCND Discussion Paper NO. 140. International Food Policy Research Institute, Washington, D.C.

Rweyemamu, L.M.P. 2006. 'Challenges in the development of micronutrient-rich food ingredients from soya beans and Moringa oleifera leaves'. *Proceedings of the Conference: Moringa and other highly nutritious plant resources: Strategies, standards and markets for a better impact on nutrition in Africa.* Accra, Ghana, November 16-18.

Sauveur, A.D. and Broin, M. 2006. 'Fighting malnutrition with Moringa oleifera leaves: an untapped resource', *Proceedings of the Conference: Moringa and other highly nutritious plant resources: Strategies, standards and markets for a better impact on nutrition in Africa*. Accra, Ghana, November 16-18.

Sauveur, A.D. and Hartout, G. 2001. *Moringa culture and economy in Niger*. In Fuglie, L.J. (ed). 2001. The Miracle Tree. Dakar, Senegal.

Sena, L.P., Vanderjagt, D.J., Rivera, C., Tsin, A.T.C., Muhamadu, I., Mahamadou, O., Millson, M., Rastuszyn, A. & Glew, R.H. 1998. 'Analysis of nutritional components of eight famine foods of the Republic of Niger', *Plant Foods for Human Nutrition,* 52,17-30.

Seymour, J. 2003. *The new complete book of self sufficiency*: *the classic guide to realists and dreamers*. London: Dorling Kindersley.

Shava, S. 2000. *The Use of Traditional plants as Food by Rural Community in the Eastern Cape: An Educational Exploration*. Unpublished Master's Thesis. Rhodes University.

Standing Committee on Nutrition (SCN), 2007. *Fact sheets on Food and Nutrition Security Indicators/Measures. Task Force on Assessment, Monitoring, and Evaluation.* [Online]. Available at: www.unsystem.org/SCN/Publications/html/task_force/_DietDiversity_Final.doc. (Accessed: 20 March 2008)

Steyn, N.P., Nel, J.H., Nantel, G., Kennedy, G. and Labadarios, D. 2005. 'Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy?', *Public Health Nutrition:* 9(5), 644-650.

Strydom, H. 2002. The pilot study. In De Vos, A. S. (ed) 2002. Research at grassroots: for social sciences and human service professions. (2nd ed). Pretoria: Van Schaik.

Stydom, H. and Venter, L. Sampling and sampling methods. In De Vos, A. S. (ed) 2002. Research at grassroots: for social sciences and human service professions (2nd ed). Pretoria. Van Schaik

The Higher Education Academy, (nd). Action Research diagrams. [Online]. Available at: http://www.heacademy.ac.uk/assets/hlst/documents/heinfe_exchange/act_res_cycle.doc. (Accessed: 14 October 2008)

UNICEF Statistics, 2006. *Progress for Children*. [Online]. Available at: http://childinfo.org/areas/malnutrition. (Accessed: 4 December 2006)

USAID. 2006. FANTA Project. *Academy for Educational Development.* Washington. DC.

USAID Policy Determination, Definition of Food Security, 1992.

Van Averbeke, W., Tshikalange, T. E. and Juma, K. A. 2007. 'The commodity systems of *Brassica rapa* L. subsp *chinensis Solanum retroflexum* Dun. in Vhembe, Limpopo Province, South Africa', *Water SA.* 33 (3).

Van Wyk, C. E., Erlangsen, E.M., Kruger, R., Gelderblor, S., Dostal E. and Vergani, T. 1985. *Modern Home Economics*. Cape Town: Maskew Miller Longman (Pty) Ltd.

Venter, S. L., Jansen van Rensburg, W. S., Vorster, H. J., van den Heever, E. and van Zijl, J. J. B. 2007. *Promotion of African Leafy Vegetables within the Agricultural Research Council-Vegetable and Ornamental Plant Institute: The Impact of the Project. African Journal of Food, Agriculture, Nutrition and Development.* Rural Outreach Program. 7, 4. [Online]. Available at: http:// www.bioline.org.br/request?nd07037. [Accessed: 3 June 2008]

Verbeek, J. and Lomberg, K. 2005. *Mokopane, Limpopo Province, South Africa*. Qualified Persons Report, prepared by RSG Global on behalf of Caledonian Mining Corporation.

Voster, I. H. J., Jansen van Rensburg, W., Van Zijl, J. B. B. And Venter, S. L. 2007. The importance of traditional leafy vegetables in South Africa. 2007. African *Journal of Food Agriculture Nutrition and Development,* 7 (4).

Warhurst, A.M., McConnachie, G.L. and Pollard, S.J.T. 1996. 'The production of activated carbon for water treatment in Malawi from the waste seed husks of *Moringa oleifera*', *Water Science and Technology* 34 (11), 177-184(8).

Wehmeyer, A. S. And Rose, E.F. 1983. Important indigenous plants used in the Transkei as food supplements [Diets, South Africa]. Bothalia. Pretoria: Botanical Research Institute. Dept. Of Agriculture and Fisheries. Republic of S. Africa. 14 (3/4): 613-615.

Wenhold, F. and Faber, M. 2006*. Nutritional Status of South Africans with specific reference to malnutrition.* Report to the Water Research Commission as part of the project "Nutritional value and water use of indigenous crops for improved livelihoods". Pretoria.

World Health Organisation (WHO) 2000. *Malnutrition-The Global Picture*. [Online]. Available at: http://www.who.int/homepage. (Accessed: 20 March 2007)

APPENDIX A

INDIVIDUAL CONSENT FORM

The purpose of this study is to determine the level of acceptability of *Moringa oleifera* (drumstick tree) leaves and pods and to increase awareness of its nutritional qualities.

At the end of the study the leaders of this project will give a full report to the communities. The researchers will return to the communities for this purpose and will be available to discuss results with individuals.

If you would like to participate in this interview, it will take about thirty minutes of your time to answer questions about the food you eat as well as *Moringa.* All the information which you provide will be treated as confidential and never publicly attached to your name. Number codes will be used on all the forms.

You can refuse to answer any or all of the questions at any time and can ask us to leave. The researcher will answer any questions you may have about this study or, alternatively will refer them to the research supervisors.

Research Supervisors

1. Mrs. F Ferreira

2. Dr. Mearns

Do we have your permission to begin?

Yes	No

Respondent's signature _____

Respondent's name _____

House number _____

Community _____

Date_____

APPENDIX B

INTERVIEW SCHEDULE

(Indian Community-Complete Sections A, B and C)

(Bapedi Community-Complete Sections A, B, C1 and D)

SECTION A

HOUSEHOLD DIETARY DIVERSITY SCORE (HDDS)

Name of Respondent_____

Town/Area_____

Date of interview _____ Time- [:] to [:]

	QUESTIONS AND FILTERS	CODING CATEGORIES
A1	Bread, rice noodles, biscuits, or any other foods made from millet, sorghum, maize, rice, wheat.	A1…….. [__]
A2	Any potatoes or any other foods made from roots or tubers?	A2…….. [__]
A3	Any vegetables	A3……. …… [__]
A4	Any fruits	A4..... [__]
A5	Any beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds, liver, kidney, heart, or other organ meats?	A5…….. [__]
A6	Any eggs?	A6…….. [__]
A7	Any fresh or dried fish or shellfish?	A7…….. [__]
A8	Any foods made from beans, peas, lentils, or nuts?	A8…….. [__]
A9	Any cheese, yoghurt, milk, or other milk products?	A9 …… [__]
A10	Any foods made with oil, fat, or butter?	A10…… [__]
A11	Any sugar or honey?	A11 …….. [__]
A12	Any other foods, such as condiments, coffee, tea?	A12 …… [__]

SECTION B

GENERAL INFORMATION

B1. What is your age in years? (Choose the correct range)

17-25	
26-35	
36-45	
46-56	
56+	

B2. What is your marital status?

Married	1
Unmarried, staying with a partner	2
Unmarried, staying without a partner	3
Divorced	4
Widowed	5
Separated	6

B3. What is your highest educational level?

No formal education	1
Read and write	2
Junior primary	3
Primary	4
Secondary	5
Tertiary	6

B4. Where did you grow up? (Please specify) _____

B5. Do you belong to a religious affiliation where there are restrictions on food that you may consume?

Yes	1
No	2

B6. If yes, please indicate the foods you are restricted to:

_____

SECTION C

MORINGA QUESTIONS

C1. Do you consume *Moringa* (Drumstick tree)?

Yes	**No**

C2. Which part of *Moringa* do you consume?

Leaves	**Pods**	**Flowers**	**Root**	**Other**

C3. Does *Moringa* become scarce at certain times of the year?

Yes	**No**

C4. If yes, during which months is there a scarcity of *Moringa?*

MONTHS	**Leaves**	**Pods**	**Flowers**	**Roots**	**Other**
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY					
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

C5. Why do you consume *Moringa*?

It is nutritious	For health reasons	It is tasty	It is readily available; not bought

C6. Other reasons (Please specify)

_____

_____

C7. In which of the following dishes do you use *Moringa*? (Please specify):

Part of plant	**Meat**	**Chicken**	**Fish**	**Vegetables**	**Other**
Leaves					
Pods					
Flowers					
Root					
Other					

C8. Do you harvest, process and store *Moringa*? (If *yes*, please specify)

Parts Stored	**Harvest**	**Process**	**Storage Method**
Leaves			
Pods			
Flowers			
Roots			
Other			

C9. Do you know of other uses of *Moringa,* apart from its being used as food?

Yes	**No**

C10. If *yes,* please state the other uses:

Parts	**Uses**
Leaves	
Pods	
Flowers	
Roots	
Other	

C11. Will you recommend the usage of *Moringa* to others?

Yes	**No**

C12. Please give reasons for your answer to the above question:

_____

_____

_____

_____

C13. Are you willing to be part of a group to prepare dishes with *Moringa* leaves and pods for women from another cultural grouping?

Yes	**No**

QUESTIONS ON TRADITIONAL VEGETABLES

SECTION D

NON CONSUMERS OF MORINGA

D1. Please list five traditional plants that you consume?

Type of plant

D2. Which part of the plant do you consume?

Leaves	**Pods**	**Flowers**	**Roots**	**Other**

D3. Does the plant become scarce at certain times of the year?

Yes	**No**

D4. If yes, during which months is there a scarcity of the plant?

MONTHS					
JANUARY					
FEBRUARY					
MARCH					
APRIL					
MAY					
JUNE					
JULY					
AUGUST					
SEPTEMBER					
OCTOBER					
NOVEMBER					
DECEMBER					

D5. Why do you consume the plant?

Name of plant	It is nutritious	For health reasons	It is tasty	It is readily available - not bought.

D6. Other reasons (please specify)

_____

_____

_____

7. In which of the following dishes do you use the different plants you mentioned? (Please specify):

Name of plant	**Meat**	**Chicken**	**Fish**	**Vegetables**	**Other**

D8. Do you harvest, process and store parts of the plant for future use?

Yes	**No**

D9. If *yes*, how do you harvest, process and store it? (Please specify)

Name of plant	Harvest	Process	Storage Method

D10. Do you know of other uses of the plant, apart from it being used as food?

Yes	**No**

D12. If *yes*, please state the other uses:

Name of plant	**Uses**

D11. Would you like to know of another leafy vegetable that easily grows in your area and is very nutritious?

Yes	**No**

D12. Are you willing to be part of a focus group to taste dishes prepared with *Moringa* leaves and pods on _____. Time: _____

Yes	**No**

D13. Would you like to learn more about *Moringa* as a plant to be added to your dishes as a green leafy vegetable?

Yes	**No**

D14. If *yes,* please give your contact details and you will be notified of when a focus group session will be scheduled.

Contact number _____

THANK YOU!!!

APPENDIX C

HEDONIC TEST OF PERSONAL PREFERENCE OF DISHES PREPARED FROM LEAVES AND PODS OF *MORINGA*

FOCUS GROUP - BAPEDI

Name of respondent: _____

Product: _____

Date: _____

Instructions: Rank the food from 1 (very poor) to 5 (very good) in each of the following categories.

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste					
Odour					
Mouth feel					
Appearance					
Total					

TOTAL SCORE: _____

What did/didn't you like about the Moringa dish and why?

_____

_____

_____

_____

APPENDIX D
RECIPES FOR DISHES PREPARED

Peri-urban community

***Moringa* and egg dish**

Ingredients

Moringa leaves – 100 g (washed and drained)

Tomatoes – 3 medium sized (chopped)

Onion – 1 medium sized (chopped)

Eggs – 3 medium sized

Oil – 2 tablespoonfuls

Flavouring (curry powder, nutmeg) – ½ teaspoon each

Salt to taste

Method

Heat oil in a pot. Sauté chopped onion until transparent. Add chopped tomatoes. Simmer for a few minutes. Add flavouring. Add beaten eggs. Cover and simmer for a few minutes till the eggs have set. Add *Moringa* leaves. Cover and simmer for 5 minutes, stirring from time to time. Take pot off heat and serve *Moringa* relish with a starch of your choice.

Traditional community

Dish 1

Ingredients

Moringa leaves – 100 g (washed and drained)

Tomatoes – 2 medium sized (chopped)

Onion – I medium sized (chopped)

Chillies, a few – crushed

Water – 2 tablespoonfuls

Salt to taste

Method

Simmer chopped tomatoes and onions in a pot for a few minutes. Add crushed chillies. Add *Moringa* leaves. Season to taste. Remove from heat and serve.

Dish 2

Ingredients

Moringa leaves – 100 g (washed and drained)

Tomatoes – 2 medium sized (chopped)

Onion – 1 medium sized (chopped)

Oil – 2 tablespoonfuls

Salt to taste

Method

Sauté onion in oil till transparent. Add chopped tomatoes. Add salt to taste. Add *Moringa* leaves. Cover and allow to simmer for a few minutes. Remove from heat and serve.

Dish 3

Ingredients

Moringa leaves – 100 g (washed and drained)

Tomatoes – 2 medium sized (chopped)

Onion – 1 medium sized (chopped)

Oil – 2 tablespoonfuls

Peanut butter – 2 tablespoonfuls

Salt to taste

Method

Sauté onion in oil till transparent. Add chopped tomatoes. Add salt to taste. Add peanut butter and simmer for a few minutes. Add *Moringa* leaves. Cover and allow to simmer for a few minutes. Remove from heat and serve.

Dish 4

Ingredients

Moringa leaves – 100 g (washed and drained)

Tomatoes – 2 medium sized (chopped)

Onion – 1 medium sized (chopped)

Packet soup – ½ a packet

Potatoes – 2 medium sized (peeled and diced)

Flavouring, curry powder

Water – 2 tablespoonfuls

Salt to taste

Method

Boil onion in water till soft. Add chopped tomatoes. Add salt to taste. Add potatoes and allow to simmer for a few minutes. Add soup and curry powder. Add *Moringa* leaves. Cover and allow to simmer for a few minutes. Remove from heat and serve.

APPENDIX E

INDIVIDUAL SUMMARIES OF THE HTPP OF EACH DISH PREPERED IN THE TRADITIONAL PEDI COMMUNITY

Dish 1 (total score)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	2	0	0	8	30
Odour	1	2	0	0	40
Mouth feel	1	0	3	8	30
Appearance	0	0	0	0	50
Total =	4	2	3	16	150

TOTAL SCORE: 175

Dish 1 (%)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	20	0	0	20	60
Odour	10	10	0	0	80
Mouth feel	10	0	10	20	60
Appearance	0	0	0	0	100

TOTAL PERCENTAGE: 87.5

Dish 2 (total score)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	6	4	0	0	10
Odour	3	2	9	0	15
Mouth feel	6	4	0	0	10
Appearance	2	0	6	0	30
Total	17	10	15	0	65

TOTAL SCORE: 107

Dish 2 (%)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	60	20	0	0	20
Odour	30	10	30	0	30
Mouth feel	60	20	0	0	20
Appearance	20	0	20	0	60

TOTAL PERCENTAGE: 53.5

Dish 3 (total score)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	5	0	9	8	0
Odour	5	2	6	4	5
Mouth feel	6	2	3	4	5
Appearance	3	2	6	4	15
Total	19	6	24	20	25

TOTAL SCORE: 94

Dish 3 (%)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	50	0	30	20	0
Odour	50	10	20	10	10
Mouth feel	60	10	10	10	10
Appearance	30	10	20	10	30

TOTAL PERCENTAGE: 47

Dish 4 (total score)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	0	0	0	0	50
Odour	0	0	0	0	50
Mouth feel	0	0	0	0	50
Appearance	0	0	0	0	50
Total	0	0	0	0	200

TOTAL SCORE: 200

Dish 4 (%)

	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5
Taste	0	0	0	0	100
Odour	0	0	0	0	100
Mouth feel	0	0	0	0	100
Appearance	0	0	0	0	100

TOTAL PERCENTAGE: 100

APPENDIX F

OPEN ENDED QUESTIONS FOR FOCUS GROUP DISCUSSIONS-INDIANS

1. What do you know about growing and consuming Moringa?
2. In which other part of South Africa does *Moringa* grow?
3. Do you make use of *Moringa* for other purposes than cooking?
4. Is there any particular reason why you use *Moringa* in this way??
5. Do you think *Moringa* should be introduced to other people who do not know about it?
6. What are the various ways in which *Moringa* could be harvested, processed, stored and prepared? (Various recipes to be discussed).

OPEN ENDED QUESTIONS FOR FOCUS GROUP DISCUSSIONS-BAPEDI

SECTION 1

1. What are the different indigenous green leafy vegetables that are usually consumed in this community?
2. Do you know of any other uses of the traditional leafy vegetables?
3. What are the various ways in which the plants you mentioned earlier could be harvested, processed, stored and prepared? (Various recipes to be discussed).

SECTION 2

Moringa is introduced to the group and a discussion held on the various uses of the plant. Plant samples are shown to the group.

SECTION 3

Leaves of *Moringa* are given to members of the group to prepare using their own methods of preparation. After the preparation, samples are placed on plates for sensory evaluation.